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THE AMERICAN
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EDITORIAL

SYNTHETIC METHANOL.

Methanol has had a somewhat dramatic history. Long known only as one of the products of destructive distillation of wood and without important applications, it became, in its crudest form, the means of denaturing alcohol in Great Britain. Allen's "Commercial Organic Analysis" made American chemists familiar with the name but not with the nature of "methylated spirit" so largely prescribed in analytic methods. Later, processes of purification enabled the production of a high grade article almost absolute, and Dr. Benjamin Ward Richardson, a British physician of much ability and originality, but sometimes rash in his inferences, was led to suggest that in this pure form it would take the place of ethanol and serve as a valuable substitute. The refined product began to appear in quantity under misleading titles such as "Columbian Spirits," "Colonial Spirits" and very soon evidence of its peculiar toxic action on the optic nerve was noted. Numerous sad cases of blindness even by exposure to its vapor were reported.

It has always been a question whether the toxic action of methanol is due to the substance itself or to some unrecognized impurity. The ordinary explanation that it oxidizes in the system to formaldehyde, while ethanol becomes carbon dioxide and water, seems to have no positive experimental basis, though it is plausible. Heretofore the industrial source of methanol has been only the distillation of wood, but it appears from recent reports that a synthetic product is now available. This will probably bring new issues into the alcohol problem, for if the synthetic article is free from the toxic action so characteristic of ordinary methanol, a new intoxicant is added to the list and new legislation will be needed. It is, indeed, not likely that the better class of liquor users will resort to methanol,

however pure, but a large fraction of the lower class will be brought under its sway.

Some information concerning the method for synthesizing methanol is given in a paper by G. Patart, Inspector-General of the French powder works, in *Chimie et Industrie*, (1925, *13*, 179), abstracted in *Ann. Chim. Anal.*, etc. ([2], 1925, *7*, 109), from which the following data are taken. The process is an example of catalysis under high pressure, which has already shown such great efficiency in connection with the synthesis of ammonia. As usual with French scientific literature suggestion is made of early French work, when Messrs. Sabatier and Senderens attempted to combine carbon monoxide and hydrogen by the influence of finely divided nickel, but accomplished nothing of importance, because they worked at atmospheric pressure. In 1913 the Badische Anilin und Soda Fabrik, the BASF, now so well known in industrial chemistry, made a number of experiments, obtaining several aliphatic derivatives of low carbon content, but did not pursue the work to definite result. Similarly, Henri Dreyfuss failed with both nickel and platinum sponge as catalysts. Calvert in 1922 claimed to have obtained a good yield of methanol from water gas and hydrogen, but gave no details of his method. In the same year Patart took out a patent in which it was claimed that carbon monoxide and hydrogen can be combined under the influence of catalysts at a temperature of 300 degrees to 600 degrees under high pressure to form methanol, but his claim was disputed by other workers. In 1923, the BASF took out patents for a process essentially similar, but covering numerous accessory important points, such as purification of the applied gases and use of new catalysts. In consequence of the co-operation of theory and practice which is so characteristic of German industries, a large amount of synthetic methanol was produced which was at once absorbed in the color industry. French enterprise also developed the synthetic product and a small installation was operated under Patart's methods in 1922. A pressure of from 150 to 250 atmospheres and temperatures from 400 degrees to 420 degrees are employed. The statement is made that the alcohol can be produced at about 25 cents per gallon, but this, of course, is on a French labor basis and cannot be safely applied to American manufacture. It is expected that the production will bring methanol into active competition with standard motor fuels, a consummation devoutly to be wished. It

is, however, in the color industry that the production of a methanol wholly free from acetone will be of the greatest importance, and the manufacture of formaldehyde will also be materially aided. The reduction in the cost of formaldehyde will be felt in the lowering of the price of the largely used derivatives, such as bakelite.

HENRY LEFFMANN.

RESEARCH.

Research is not a "talking" word. It is a "doing" word. Still one must admit that it has "talking" qualifications. It has a most singular appeal to the lay mind as well as to that of the scientist.

Its nebulous, spiritful, undimensional idea is extremely captivating and it is no wonder that the current generation has capitalized to the utmost its potentialities in a "talking" direction.

Quite often, its siren song, purposefully amplified, has charmed the heart of many a willing philanthropist.

And it is well that this is so. For the pursuit of research, in these times, requires money more than ever before. It is quite natural, then, in our country, where pure research is an object of charity, to find this phase of science suffering from over-"asking" and over-"telling."

In Germany the Government has subsidized and capitalized research and that probably accounts, more than any other single thing, for her predominance in the organic chemical industries. That the great World War only spurred that country to greater effort in this direction is now convincingly stated in the marketing of their latest synthetic product—methanol, referred to elsewhere in this issue.

It is said that Germany throughout her hectic war-course held steadily to her research faith, to her research equipment and to her research workers. She kept them at their jobs looking ahead. Her industries were stagnant awhile but her new-business scouts, the chemists, were busy everlastingly.

Now she reaps the rewards of her vision—and the rewards of research are only to the patient and the brave.

But Germany was not handicapped like us—her Government and her industries have long since appreciated the significance of science to the present-day civilization. They have deeply invested in its long-term bonds.

Her research does not "talk." It "does."

We, on the other hand, must talk and keep on talking—to the industrialist and to the philanthropist as well.

Who live on charity awhile must also beg awhile.

But we have talked so much and perhaps too enthusiastically of the possibilities of research that false impressions have gone abroad. Too much is expected in too short a time from a too unpecunious tender to its graces. We have tried to extemporize research and it cannot be done.

It is well to remember that research is a deep-seated itch and that a superficial scratch does not reach it. But there are signs of a better appreciation of the significance of research as a "doing" proposition and these signs are showing in the right quarters.

Witness this quotation from a great business paper of the world's greatest business nation,

"American manufacturers have failed, on the whole, to understand the need for research to keep their industry at the front. German laboratories are better equipped and better manned than ever. They were developed for chemical warfare during the war and have not been allowed to deteriorate.

"American chemical manufacturers have not, generally speaking, employed competent scientists or spent the money needed to develop laboratories. When they get a jolt like this, instead of seeing their mistake and trying to remedy it, they either try to make a deal with the Germans so that they can manufacture the product here on a royalty basis or else they go to Washington to get a protective tariff to take care of their own laxness. I understand that the reports of the new German solvents have caused a fright, and that American manufacturers have asked for terms on which they may manufacture the solvents here.

"The backwardness of the manufacturer in this respect only reflects that of the general public in this country. The principal trouble here, in comparison with Germany, France and England, is that we don't appreciate to the same extent the significance of science to the present-day civilization.

"Because manufacturers as a rule fail to inform themselves on the question of research they are apt to think, when a blow like this hits them, that they can recover the lost ground in a few weeks by putting several chemists together in a building and telling them to work out this secret. Progress can't be made that way. Germany

has probably been working on this problem for a long time and the laboratory research of six or seven years cannot be extemporized in short order fashion here.

"The wood alcohol industry seems to be confronted with the choice of buying the secret, getting a high protective tariff or closing up. The whole thing will have its value if it is appreciated by American manufacturers and the public as an object lesson of our backward-looking attitude toward research."

Looking backward to our own accomplishments with pride is one thing and looking backward to the accomplishments of others with envy is another. Before we can look backward with pride we must look ahead with vision.

IVOR GRIFFITH.

ORIGINAL ARTICLES

CHEMISTRY AND COLOR.*

By J. W. Sturmer.

Dean of Science.

Color may be thought of subjectively, as a sensation perceived by the eye. We may say that the color of a substance is one of its inherent properties, and be content with this explanation. The ancients were, but we moderns are more curious, and like to know why we see things as we see them.

The perception and the appreciation of color in nature antedates all scientific knowledge. Throughout the ages, the different greens of foliage, the blue haze of distance, the riot of colors of the flowers of the field, the gorgeous tints of autumnal landscapes, the azure of the sky and of deep waters, the silver and gold and lilac and rose of the clouds at sunset, have gladdened the human heart, and inspired poetic emotions. Not until Sir Isaac Newton made certain experiments with prisms and sunbeams, did anyone suspect a connection between the rainbow and other color phenomena in nature.

The color-charms which man perceived and admired in his surroundings, he attempted, at an early date, to appropriate for personal adornment, and for the purpose of beautifying his household

*One of a Series of Popular Lectures given at the Philadelphia College of Pharmacy and Science 1924-1925 Season.

furnishings. Colored pebbles are cherished by the most primitive tribes. Colored earths, and colored ores, mixed with animal fat, provided the first paints. Stains, obtained mostly from vegetable sources, have since time immemorial served to make human habiliments more pleasing to the eye. The ruins of Persia, of Egypt, and of the palaces of Cnossus, have disclosed evidence of the appeal which colors made to the nations of the past. Joseph had "a coat of many colors."

Old Timers.

For a long, long time progress in the knowledge of colors consisted in learning how to select and use the pigments and stains provided by bountiful nature. How to prepare and mix such pigments, how to develop and apply the stains which by accident had been found to be available, engaged the attention of the craftsmen. Much empiric knowledge accumulated. And some is very old. The Egyptians knew and used some of the dyes which are in use today, a fact discovered when the fabrics from ancient tombs were examined by modern scientists.

When the ruins of Pompeii were exposed to view, there were found, near the Pompeiian dye houses, heaps of shells of a snail-like mollusc, a secretion of which provided the Tyrean purple, the brilliant coloring matter used to dye the robes of the aristocrats of that distant day. And Pliny tells us that when the ancient Britons sallied forth to battle against the Roman invaders, these savage warriors fought in their war paint—a deep blue stain applied to their faces and bodies. More recent writers identify this stain as woad, a dyestuff obtained from Isatis tinctoria, a plant of the mustard family; and they derive its name from Woden, the deity of the ancient Saxons. We now know that this blue substance can be developed from a variety of plants, notably from the indigo plant of India, which had been in use for centuries by the nations of the East before the advent of the invasion of the British isles. We know also that the blue dye of the ancient Britons, and the blue of the Roman invaders, as well as the blue of old Egypt, are identical, though obtained from different plants, and from different localities. It is, indeed, the same blue dye which is in use today, namely, indigo. This indigo is a definite chemical compound, always exhibiting the self-same properties, regardless of its origin; and the modern chemist can make it from a substance separated from coal tar.

Another ancient vegetable dye is Turkey Red, obtainable from the root of Rubia tinctoria. When, about 150 years ago, the descendants of the ancient Britons contested with the troops of Washington for the country in which we live, red was the dominant color of the British uniform, and Rubic tinctoria provided the dye. To be sure, many other vegetable colors were in use also—yellows and browns and blacks. But indigo, and Turkey Red, also called madder, were the principal colors of many nations, in war and in peace, and these dyes occupied this place of prominence for a long period. Turkey red, like indigo, is used in great quantity today. As in case of indigo, the chemical make-up of Turkey red is known; so this substance also may now be manufactured artificially, by the processes of synthetic chemistry, from something which is found in coal tar. Even Tyrean purple, the royal purple of the ancients, can be synthesized by the chemist. The only reason why this is not done commercially is that we have superior red dyes of coal tar origin with which the dye of the ancients, laboriously developed from the secretion of molluscs, cannot compete.

Dyes from Coal Tar.

Not only has chemistry shown the way to the duplication of the coloring matter from animals and plants, it has also brought about the production of a large number of chemical compounds which have no counterpart in nature, but which serve excellently as dyes. Indeed, more than a thousand coal tar dyes are now obtainable through the regular channels of trade, and procurable at a moderate price, so that brilliantly colored raiments are no longer limited to the adornment of the rich. And all these dyes, of all the colors of the rainbow, and their tints and shades, some permanent, others fugitive, some poisonous, others harmless and adaptable for food coloring, some which dye wool or silk, others for cotton, some to be used in one manner, others in quite another—all are made from substances found in coal tar! And all this development in synthetic chemistry has come within the memory of persons now living. It was in 1856 that a young English chemist by the name of Perkins, working on the synthesis of quinine, made some experiments with crude aniline, and obtained a mauve-colored substance. Some years later this accidental result led to the production of the first synthetic dye, which explains the popular name, aniline dyes, for coloring matters of this

type, a name which has prevailed despite the fact that the great majority of coal tar dyes are not really aniline derivations.

What the development of these products has done to the industry based upon the utilization of vegetable and animal dyes, may be imagined. The cultivation of the indigo plant, of Rubia tinctoria, and of other dye-plants, no longer pays. Idle stand the vats where this color-producing material was macerated, fermented, and manipulated, *secundum artem*, while the business of making synthetic dyes is increasing in volume and in the diversity of its output. And as for the molluscs which provided the Royal Purple of Solomon and of Cæsar, those lowly creatures of the sea may now round out their full span of life undisturbed in the waters of the Mediterranean.

Yes, chemistry may be said to have solved the dye problem—solved it in a few decades, and rendered useless all the empiric knowledge which has been accumulated throughout the centuries. It solved the mystery of the chemical composition of the important dyestuffs of the past. It made possible their synthesis. And it added to this list, a thousand dyes which nature failed to provide, except potentially, in coal tar.

To duplicate synthetically a coloring matter of plant origin, it was necessary first of all to determine its chemical make-up—to find out what elements are present in the compound—in what proportions or ratios these elementary atoms are grouped in the molecule, and to ascertain the relative weight of the latter. In other words, the chemist had to determine what is known as the structural formula of the substance, a task which was impossible until the science of organic chemistry had reached a fair stage of development. In reaching this advanced position, chemists produced—or shall we say created—many thousands of new compounds, each of which was promptly examined as to its physical and chemical properties. Some of these, as for example trinitro-phenol, were found not only to exhibit color, but to have the property of clinging so firmly to fabric that water fails to remove them. It was, therefore, natural that such compounds should have been experimented with as dyes, and that those which stood the test should have been utilized in this capacity.

Chromophores.

When a considerable number of such chemicals had come under observation, chemists proceeded to generalize from the facts ob-

served, and it was noted that certain types of compounds were apt to exhibit color, and that the introduction of certain groups of atoms was responsible for the development of this property. It was found that a certain arrangement of the atoms within the molecule produced a certain dye; and that a different arrangement produced a compound of a different color, or of a different tint or shade, or of no color whatsoever. All these observations were jotted down. Accordingly, the search for new dye compounds became progressively more scientific, and less empiric or haphazard. Chemists then began to speak of chromophores—meaning the atom groups upon which depends the color of the compound.

Mordants.

But it is not enough that the compound which is to function as a dye possess color. It must, as has been observed before, cling to the fabric, and not wash off. It must, moreover, be fairly resistive to the action of the atmospheric gases, and to the action of sunlight. If it does not possess these properties—if it is oxidized in air, or reduced by sunlight—it is, of course, too fugitive for practical use. And yet, there must not be perfect stability, for a certain tendency to oxidation, or to reduction, seems to be associated in a compound with that property which manifests itself as color. Hence it is that we can remove stains by the use of oxidizing agents, like bleaching powder, or with reducing agents, like sulphurous acid. These chemicals alter the chemical composition of the dye, producing colorless products, in the first case by oxidation, in the other, by reduction. Another interesting fact with reference to dyes, is that some fail to cling to certain fabric, as, for example, cotton, except with the intervention of a foreign substance, which, when thus employed, is known as a mordant. Alum, chrome alum, tin salts, and other compounds, are thus employed as mordants, and their use is not by any means limited to the dyeing with synthetic dyes, but is essential also when vegetable or animal colors are resorted to.

Now, it may be that a dye adheres firmly, without the help of a mordant to one type of fiber, like wool, but refuses to cling to cotton. That is to say, it exhibits a selective action. This fact is utilized in various ingenious ways by the scientist. If, for example, one places a drop of para-nitraniline hydrochloride solution on this paper, it will produce no conspicuous stain. If one drops the same solu-

tion on news-paper, it will develop a deep yellow spot. The reason is that the book paper is made of "chemical wood pulp," and is nearly pure cellulose, whereas the news-paper is printed upon stock made up largely of "mechanical wood pulp" from which the lignin, and other compounds natural to wood, have not been removed; and para-nitraniline seeks out the lignin, and stains it, while it refuses to stain cellulose. The practical microscopist uses a number of such stains which have selective action, and he is thus enabled to distinguish more clearly the different kinds of cells and tissues in his microscopic mount. Differential staining is used also in the technique of identifying micro-organisms, some of which "take" one kind of stain, while others have an affinity for a different stain—an observation which, by the way, led Ehrlich to develop a new line of attack in combating certain diseases, namely, by medication with therapeutic agents of the character of dyes exhibiting a selective affinity for certain micro-organisms which may invade the human body.

To enumerate the common synthetic dyes, explain their chemical nature, and to give their characteristics, would carry us too far afield in the realm which belongs to the specialist. But it is an interesting fact that all synthetic dyes are derivatives of ring or closed chain hydrocarbons, like coal tar benzene, naphthalene, or anthracene, or of their homologues, no colors being obtainable from the open chain hydrocarbons, such as are found in petroleum. Yet all ring hydrocarbons are colorless, and color results only when a certain color-giving group of atoms, called a chromophore group, is introduced into the molecule. A number of these chromophore groups contain nitrogen, as for example, the nitro group, and the azo group. Some contain also sulphur, as in the thioazines, while one of the most important groups contains only carbon, hydrogen and oxygen. But the chemical composition of dyes is exceedingly complex, too complex for discussion in this lecture. Let us, therefore, pass on to another phase of our general subject.

Lakes.

Some dyes, as has been stated, can be made to adhere to certain fabrics only when a mordant is employed. Mordants are, speaking generally, compounds of metals, or are acids, and they appear to combine intimately with the dye, sometimes with the devel-

opment of a different tint or shade or color. Now similar in some respects to the combination of dye and mordant is the chemical union of a dye with some other compound or compounds with the formation of a product which has more "body" than the dye itself, and which exhibits greater opacity. Thus is produced in fact, a kind of pigment, adapted for suspension in suitable media. Pigments made from dyes in this manner are called *lakes,* a name derived from *lac,* which in turn comes from *lahk,* a Sanskrit word harking back to a very ancient dye, known before the days of Moses, and obtained from a scale insect. This insect provides two distinct products, a varnish resin familiar to us in the form of shellac, and a coloring matter similar to that procurable from the Mexican cochineal bug. Now lahk in the Sanskrit meant one hundred thousand, or a great number. Why this name should have been employed for a coloring matter, and also at a later date, in modified form, for a resin, becomes clear when we read that these insects, at certain seasons of the year, appear in countless numbers, and cover the twigs of trees and bushes very much like the San Jose scale covers fruit trees in this country. So it appears that the words lac, and lacquer, and the more modern term lake, have a common etymology.

Lakes can be made of vegetable or of animal dyes; but the majority of them are nowadays made from coal tar colors. These pigments combine the brilliancy and depth of color of such dyes with the body and the opacity of mineral pigments, to which, however, they are apt to be inferior in point of permanence. Lakes play an important role in color printing. Our colored newspaper supplement is printed with ink made from lakes. So is our wall paper; and so are calicoes and similar printed fabrics.

One of the best-known lakes of the older type is carmine, made from the coloring matter of cochineal, the name carmine being a corruption of the word Kermes, which is the name of the Asiatic insect previously referred to as one of the most ancient dye substances. Lakes are named, in many cases, by compounding the word lake with an adjective denoting a color, as for example, orange lake, crimson lake; or the name of a dyestuff may figure, as in indigo lake, madder lake, alizurine lake, ponceau lake, safranine lake, etc. Some have names of geographic significance, as, for exmple, Berlin lake.

The manufacture of lakes is a highly specialized industry, and has been brought to a remarkable degree of perfection, although the

underlying science is still in a formative stage. Briefly, it may be said that some dyestuffs are acidic in character, and are combined with barium, lead, aluminum, tin, zinc or other metals, salts of which are employed in the production of the lake. Other coloring matters are basic, and are precipitated with acids, notably with tannic, arsenous, phosphoric, oleic, stearic, antimonous acid, and the like. A lake is sometimes given greater body and opacity, or changed in other respects, by being precipitated upon such insoluble mineral matter as, for example, barium sulphate, china clay, zinc oxide, aluminum hydrate, and even upon red lead, or lampblack, a process which is employed also in the production of certain modern pigments for the paint industry, and which accounts for such products as American vermilion, a pigment quite different from true vermilion which is mercuric sulphide.

The transition from lakes to pigments—using the latter term with the connotation popularly applied to it—involves passing from very complex compounds to relatively simple ones.

Pigments.

The pigments found in nature may be colored clays or earths, like ochre, sienna, or Van Dyke brown, or they may be minerals of rather definite chemical composition, like orpiment, which is sulphide of arsenic. But by far the greater number are laboratory products—distinct chemical compounds, the manufacture of which is based upon the well-known laws governing chemical reactions. Some occur as by-products in the production of other compounds, as, for example, the red ferric oxide, which is the residue left in the retort when fuming sulphuric acid is made from pyrites.

In the early periods of human progress, only the pigments from colored earths and from colored minerals were available. Our American Indians were limited to such pigments, and their war paints, not counting the vegetable stains, were largely earths colored with oxide of iron, although the tribes of certain localities used also cinnabar and orpiment. But it should be remembered that there are chemical processes of manufacture which antedate by many centuries the era of scientific chemistry. Thus soot, as a black pigment, the forerunner of our lamp black, is found in the oldest of cave drawings, while a process for making white lead—a process almost identical with the Dutch process—is described in the writings of Diascorides, who was a contemporary of the Apostle Paul.

It is, however, true that most of our present-day pigments, those for artists' use as well as those for house paints, are relatively recent accessions, and that the palettes of our early painters exhibited a poverty of colors which would seriously hamper a modern artist. Chrome yellow, English vermilion, red lead, Prussian blue, Scheele's green, and scores of other pigments in extensive use by the industry which strives to "save the surface" and by this means to "save all," are products of the chemical laboratory, and their manufacture is now conducted on a large scale, with the employment of modern factory methods.

What Is Color?

But why, let us ask, is lead chromate yellow? Why is artificial mercuric sulphide red? Why does any dye or pigment exhibit the color we have learned to associate with it? Why do some substances possess color, while others are colorless? What, really, is color? The answers which science offers may not be wholly satisfying; but they provide a clue which may eventually point to a solution of the mystery. Let us consider another question: Is the color of a substance a specific property dependable upon the elements in a compound, and upon the ratios existing between the atoms of such elements? The chromophore hypothesis might lead us to infer this. But what shall we do with the following facts? Mercuric sulphide may be as black as soot; mercuric sulphide may also be scarlet, a variety known as English vermilion. Mercuric oxide may be yellow, or it may be bright red; and as far as a chemical analysis goes, the two varieties are identical. Mercuric iodide is scarlet, changes to yellow on heating, retains this color on cooling, but suddenly changes back to the scarlet substance when it is touched—say with a lead pencil point. Cuprous-mercuric iodide is red, changes to dark brown when heated to about 75 degrees C., and assumes its initial color, namely, red, on cooling, even though it be not touched or disturbed. Nor are such seeming vagaries limited to compounds of mercury. Every chemistry student knows that ordinary waxy phosphorus, which is virtually colorless, or of the color of very pale amber, may be changed to a variety of phosphorus maroon red in color, yet both varieties are phosphorus an elementary substance. To be sure, these varieties of phosphorus have other points of dissimilarity besides those as to color; and the same may be said of the compounds mentioned.

Selective Reflection.

But the point is that we must look beyond the facts disclosed by the chemical symbol or formula for the clue which may lead to the solution of the riddle, why any given substance exhibits a certain color. So let us shift our attention from dyes and pigments, and briefly consider the subject of light, for in the absence of light no colored substance exhibits its color characteristics. What really is light? As early as 1668 Sir Isaac Newton had demonstrated the composite character of solar light. The artificial rainbow he succeeded in producing was called the spectrum, a name which implies its phantom-like character, for these color effects proved to be as immaterial as a shadow; one can not dip a brush in them and transfer them to canvas. They are the spectral or ghost colors.

Since Newton's day science has demonstrated conclusively that light travels in waves which are transverse to the direction of the ray, that white light is composed of waves which differ in length, and that the light of which the human eye can take cognizance, is made up of waves ranging from about .33 to about .8 of a micron in length—and a micron is 1/25,000 of an inch. Waves longer than .8 of a micron are invisible, and are known as infra-red waves, or somewhat inaccurately, as infra-red light, while waves shorter than about .33 micron constitute ultra-violet waves, or, if you will, ultra-violet light. The X-rays are exceedingly minute as compared with light waves, while the waves tuned in by our radio, are vastly longer—city blocks in length.

Now it appears that our interesting and active little electron within the atom, by virtue of its activity, tunes in certain wave-lengths of the radiant energy which we call light, and refuses to tune in certain others; and the waves which are not tuned in are transmitted or reflected, and determine the color of a substance. Thus, a red pigment, it may be understood, tunes in all the wave lengths except those which give to the retina of the human eye the sensation of red color. A substance which reflects all the wave lengths, reflects without exercising selectivity, is white; one which absorbs all, without selective reflection, is black. But it should be understood that our common pigments do not reflect pure spectral hues, but mixtures of them.

At this point we may profitably try an experiment. Let us set fire to some wood alcohol which has been poured upon some common salt in an evaporating dish. As the wood alcohol burns, the heat

generated volatilizes enough salt to tinge a distinct yellow the colorless flame first observed. If now we turn out all other light, and view in the glow of our sodium flame, fabrics dyed in all the colors of the rainbow, we find that only the yellow fabric shows its characteristic color, all other fabrics appearing black. In like manner, red lead looks black; so does chrome green; and also ultramarine and the violet crystals of chrome alum. But lead chromate, called chrome yellow, exhibits its color under the sodium flame.

Now the sodium flame is monochromatic light, which means that it is not composite as to wave-length, but is made up of waves of a uniform or nearly uniform length (about .59 microns), and only the lead chromate, and the dye in our yellow fabric, reflect these waves, all the other colored substances absorbing this light. As the red, the green, the blue, and the violet objects received no light waves which they could reflect, but only yellow light waves, which they "tune in" and absorb, these objects could not show color. So we are forced to the conclusion that color is *light,* and that the property by virtue of which a substance exhibits a specific color can be made manifest only when light waves of that color are made to impinge upon it. In other words, it is all a matter of selective absorption—and reflection—of certain wave-lengths of radiant energy.

Structural Colors.

This applies, however, only when the color seems to be inherent in the substance, as in case of pigments and dyes. It does not apply to such color phenomena in nature as the rainbow, nor does it apply to the colors of a soap bubble, or of a film of oil on a wet pavement, which are phantom colors, usually spoken of as structural colors. In case of the rainbow there is no selective absorption of certain wave lengths, but merely a dispersion of light, due to the fact that the droplets of water, acting like prisms, refract the light that is transmitted, alter the direction of the light waves, and this to a degree dependent upon their lengths, thus causing the constituent colors of white light to spread out fan-like, so that those of longest wave length, namely, the red, are at one extreme, and the violet, which are the shortest, at the other, for the shorter the waves the greater is their refraction by the prism. This display of colors is technically called a solar spectrum. Spectral hues are exhibited by the diamond, by prisms of glass, and by certain liquids like carbon disulphide, when these are traversed by white light.

The colors exhibited by the soap bubble, by a film of oil on water, by fish scales, by opals, by certain laminar rock, like mica, by the wings of the dragon fly and other insects, by certain bird feathers, are largely the results of interference of light waves, though in some cases, as in opals, pearls, insect wings, etc., diffraction plays a part also. The phenomenon of interference is produced only when white light plays upon an exceedingly thin layer or film of a transparent refracting substances, and the play of colors is due to the interference of light waves reflected from the top surface of such a medium, and the light waves reflected from a layer of air, or other material, with which the medium is in contact. The analogy of waves in water will help us to understand this. When water-waves, moving in different directions, intersect, we find that if their troughs and their crests coincide, the disturbance is augmented at the point of intersection. If, however, crest meets trough, the one wave compensates for the other and the disturbance is minimized or annihilated. And in like manner, the light-waves emanating from points above and from points below a film of oil, for example, may interfere and when a color wave is thus annihilated, the complementary color is observed.

A film or layer to produce color effects by interference must be exceedingly thin, thinner than the length of light waves; that is to say, must be from 1/50,000 to 1/100,000 of an inch, or thereabouts, in thickness. As such a film or layer is usually not of uniform thickness, and as the refraction index of course remains the same, it will show a certain color at one point, and a different color where the film is thinner or thicker. Thus we get the effect of rainbow colors. In case of carborundum crystals the play of colors is very gorgeous, and is said to be due to the fact that these crystals are covered with a thin layer of silica, which serves as the transparent, refracting medium. Some bituminous coal, popularly known as peacock coal, shows interference colors. So do polished surfaces of silver or copper when they have been exposed in an atmosphere containing hydrogen sulphide, in which case a thin layer of the sulphide of these metals acts as the refracting medium. A similar effect is produced by burnished iron or steel, which has been heated in a flame. Here the explanation lies in the fact that a thin layer of oxide is produced. A new spatula, held in the Bunsen flame, or a new copper water bath, which has been allowed to "go dry" over a flame, shows this effect beautifully. Mica gives the color effects of

interference, due to the fact that this substance has a laminar, that is, a layer, structure, with light reflected from the upper and the lower surface of the top layers.

Scattered Light.

A cumulus cloud, floating in the northern sky on a bright afternoon, reflects all the wave-lengths of the visible light, and appears like a great ball of white cotton. Unsized white paper, like filter paper, reflects light in a similar manner, namely, with diffusion. This is due to the fact that the surface is made up of countless inequalities, so that the light is caught at many angles, and is reflected in corresponding directions. Glass, the surface of which has been ground, exhibits no lustre, but reflects scattered light. If, however, the light is reflected from a smooth surface, with the particles of the homogeneous material closely packed, and the inequalities not exceeding about a quarter of a wave length of the light waves, the reflected light is not diffused, and we observe what is known as lustre. If the object is of a substance of very low penetrability, and with a refractive index within a certain range, the lustre may be of the kind spoken of as metallic, because most metals, when polished, reflect light in this manner. But metallic lustre is not limited to metals, and is observed in the crystals of a number of organic dyes, is possessed by lumps of indigo, of Prussian blue, and with modifications, by the hard wings of certain beetles, and by some bird feathers. A wavy surface seems to augment this effect, and the surface of water, gently rippled, when viewed by moonlight, appears to have metallic lustre. So does a test tube filled with air, when viewed under water, look as if it were full of mercury. In case of certain metals white light is reflected with little or no selective absorption. Gold and copper are, however, capable of absorbing selectively the shorter wave-lengths with reflection of the red end of the spectrum, diluted, of course, with a considerable amount of white light.

Color Modified by Powdering.

If now we examine a crystal of potassium dichromate, we note that while it reflects light, it also transmits it, and that it is fairly transparent. We also observe its orange-red color, due to selective

absorption, the unabsorbed light waves being reflected or transmitted. If we powder the crystal, its color will appear less pronounced. The impinging light will now not penetrate so deeply, and our powder is in fact opaque, for the spaces between the particles are filled with air, and the index of refraction of the potassium dichromate grains is different than the refractive index of air. So it is opaque for the same reason that a mass of ice crystals is opaque or a snowball is opaque. The reflected light will be diffused or scattered, as the crystal particles will present countless surfaces, facing in many directions. Every colored substance which is transparent or translucent, will appear lighter in color after it has been powdered. If, however, the substance is exceedingly opaque, and of a character to diffuse or scatter the reflected light, no appreciable difference in color will be noticed after powdering. Thus, the crystalline red mercuric oxide becomes yellow when reduced to a fine powder, while lumps of yellow oxide of mercury show no appreciable change in color when subjected to subdivision. Red oxide of iron is another conspicuous example of a substance which varies in color with the degree of subdivision, varies from yellow for very fine particles to deep red for larger ones.

Another reason why a pigment in large grains appears richer in color than the same pigment in fine powder is found in the fact that the large grains pack loosely, and we see the effect of multiple reflection, as light enters between the grains and the unabsorbed waves are reflected back and forth, repeatedly, and the color is thus purified. For the same reason the inner surface of a golden cup will appear much redder than the surface on the outside; and velvet will appear richer in color than will silk dyed with the same dye substance—a matter of multiple reflection.

Selective Scattering.

All cases hitherto considered involve color-effects due to selective absorption, or to dispersion, or to interference of waves from the upper and the lower surface of a film. But none of these explanations fit such phenomena as the sunset colors of the sky, nor do they help us to understand why the clear sky when the sun is near the zenith, is ordinarily blue. It appears that particles, by virtue of their dimensions, rather than by their inherent nature, scatter light selectively. Thus the minute particles in the atmosphere, scat-

ter blue light. A similar effect can be produced in water by dropping into it a few drops of an alcoholic solution of mastic, which is really an amber-colored substance. Zinc oxide, in exceedingly fine subdivision, is bluish. Glass which has an opaque white powder diffused through it, always shows, if it is not too opaque, a distinct bluish tinge. So does skimmed milk.

Professor Bancroft has obtained the same result of scattered blue light by heating hard glass tubing until it began to devitrify. It has been demonstrated also that the blue color of the feathers of the blue jay, of the blue bird, and of other blue bird feathers is due to the scattering effect upon light by the minute air bubbles in the transparent substance constituting these feathers. Similarly, the color of colloidal gold, both in aqueous media or in glass, is either red, purple or blue, according to the size of the particles. The smoke from the burning end of a cigar is quite blue, while the smoke blown from the mouth of the smoker is white—probably because, on account of its high moisture content, it is made up of larger particles which reflect all the wave-lengths. When the sun is near the horizon, and shines through denser layers of atmosphere, laden with smoke, dust particles and water droplets, we observe selective transmission, as in the case of a colloidal solution; and of course, selective scattering plays a part. As the yellow merges with the sky-blue, there results a greenish tint; and red and blue give us purple, which diluted with the white light reflected from fluffy clouds produces the lilac and amethystine hues. Dense clouds before the sun are opaque, and show black; if they are less dense, permitting white light to filter through, they appear gray; and the gray, with red and yellow, in various proportions, adds to the variety of tints and shades of the evening sky.

Dichroism and Fluorescence.

Turning now from the color phenomena of the sky to the prosaic solids and liquids in our laboratory, we may with profit briefly consider yet another interesting fact connected with selective reflection and transmission of light waves. We find that most transparent liquids and solids possessing color, as for example, copper sulphate solution, or copper sulphate crystals, exhibit the same color by reflection as they do by transmission. Moreover, a weak solution of copper sulphate has the same color as a strong solution, a

thin fragment of crystal is blue just as a large crystal is blue. The only difference is the depth of color—a matter we can readily understand.

But a weak solution of methyl violet is bluish, while its concentrated solution looks red. Indigo carmine solution has this same characteristic. It is indeed a property of a rather large number of dyes, and of other substances, and is known as dichroism—from the Greek prefix di—meaning two, and the Greek word for color, namely chroma. The explanation of dichroism is found in the fact that these substances show a difference of permeability to the different wave-lengths which are not absorbed. When this difference is very pronounced, the reflected color is different from, and usually complementary to, the color which is transmitted. A number of dyes are decidedly dichroic. Erythrosine offers an illustration.

Dichroism should not be confused with fluorescence, which involves also the transformation of short wave-lengths of radiant energy into longer waves, and which may be instrumental in rendering visible, wave-lengths which are too short for human vision, namely, the ultra-violet rays. Fluorescence was first observed in fluor-spar, hence the name. Solutions of fluorescein, uranin, aesculin from the bark of the buckeye tree, quinine sulphate, are fluorescent. The greenish "bloom" of lubricating oils from petroleum is due to fluorescence. Calcium tunstate is fluorescent and is used largely in connection with X-ray work, being the basis of the fluorescent "screen."

Phosphorescence.

Phosphorescence, it should be remembered, is distinguished from fluorescence in that it involves the emission of light "in the dark." A substance possessing this property, will when exposed to radiant energy, become luminous, and will continue to glow after the exciting light has ceased to impinge upon it. True phosphorescence does not involve the chemical alteration of the substance; at least not in the sense in which this is the case when phosphorus glows, this being a matter of oxidation. Nor is the term itself, phosphorescence, referable to phosphorus, but was derived from Bolognese phosphorus, a common name for impure barium sulphide, which is characterized by this property of glowing in the dark. Other common phosphorescent substances are the impure sulphides

of calcium, and of zinc; and these three sulphides are common ingredients in "luminous paints." A very large number of substances are fluorescent or phosphorescent to a slighter degree. The difference between these sulphides and the compounds of radium, with reference to luminosity, is simply this: radium in its disintegration produces its own radiant energy, while phosphorescent substances must be activated, or "charged," with light from another source.

Color Screens.

Most common substances are presumed to reflect light only while this is being received—as does the moon. Nor are there many substances which alter wave-lengths of the visible spectrum. Hence a pigment or a dye, that is, a substance capable of selective absorption and of selective reflection, can exhibit its characteristic color only when viewed in light which embodies the wave-lengths which the substance reflects. And in this connection it should be remembered that gas light, incandescent light, in fact, artificial light generally, is somewhat different in composition from sunlight, being richer in the yellow waves. A colored substance will therefore appear different under such light. When tinted electric light bulbs, or tinted shades are employed, these do not add something to the light, but subtract from it. They operate as filters, absorbing certain wave-lengths, and transmitting the remainder. Thus a red bulb does not add red but transmits the red rays of white light, absorbing the rays of shorter wave-lengths. If the red glass is designed to serve as a perfect filter, only substances reflecting red will show color, and all other colors will appear black. But since most pigments reflect other colors besides their dominant hues, the use of colored globes and shades not only lowers the illumination, but may produce rather bizarre effects on our wall paper, and on the furnishings of our dwellings.

Color-blindness.

But as to that, let us remember that we do not all see alike anyway, when it comes to color perception. Some folks, in fact, are color-blind, which seldom means that they cannot see color at all, but means that they cannot see all the colors. The commonest type of color-blindness is red-blindness while occasionally green-blind persons are encountered. The great John Dalton, who formulated our

modern atomic theory, was red-blind, and was the first to scientifically describe this affliction, which, even to this day, is occasionally referred to as Daltonism. A red-blind person lacks range in "tuning in" the waves of the spectrum, and the longer waves which give to normal eyes the sensation of red, are not perceived. Naturally, other colors are correspondingly modified. To a color-blind person the hues of sky and fields, of our familiar flowers, our dyes and paints and pigments, bring color-sensations quite different from those which are conveyed to you or me. So we come again to our initial statement: color may be thought of subjectively, as a sensation which we receive through the eye. Regardless of all that science can teach us about color, it's something we see; and as to this phase of it, there is much which we cannot as yet see to understand. We do not know why a certain wave-length should make us "see red"—it's a mystery.

The Unsolved Riddle.

In the objective study of color we have a great accumulation of facts—about wave-lengths, reflection, refraction, diffraction, dispersion, interference, scattering, selective absorption; about pigments and dyes, and their chemical make-up; about chromophores, and how to synthesize compounds which possess color. Science has also gone beyond the demonstrable facts into the realm of speculation, and has tried to evolve a hypothesis connecting the phenomenon of selective absorption with the electron theory. But here we might remember that a hypothesis is "a theory on probation," and that speculative thought in science means reasoning from premises not yet proven.

——, a professor and his young son, passing along Main Street, encountered an elderly person with a big red nose. "Homo sapiens proboscis rubiflora," said the professor to himself in an undertone, for he had the habit of cataloguing all strange specimens which came to his notice. But the little boy cared nothing about biologic nomenclature, and less about Latin. His was the curiosity of the true scientist. "Why," asked he, "why is that man's nose so red?"

Why, indeed? Much could be said on that subject. It could be dealt with from the standpoint of physics, or of chemistry. It is a problem in pathology. And as a theme for the moralist or the humorist a red nose is inexhaustible.

But when it came to the fundamental question, "why," our professor deemed it wise to say to his son—very simply—"Color, my son, is one of the great mysteries, and a mystery is something about which we know only enough to make us curious."

And this, indeed, is what science is still compelled to say about color. We know just enough to make us acutely curious.

PRACTICAL DISINFECTION.*

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Health is not the monopoly of any group or class. It is the common heritage and therefore should be the common property of all. Many are diseased because of a lack of knowledge of the important facts relating to health, and one of the main purposes of these series of lectures is to give everyone the store of knowledge which the field of science possesses.

No one who has observed the progress of civilized countries along sanitary lines, can fail to have arrived at the conclusion, that changes for the better have taken place during the past number of years. Much of this is due to an enlightened public consciousness in all that concerns the well being of the everyday citizen. It is true that more could have been done; but if you realize that measures advancing the cause of public health are at first most frequently met with restraint, you will agree that caution and watchful waiting are the only available policies and these necessarily result in slower progress.

More work needs to be done in developing effective methods for the prevention of many of our diseases, and to rid environments of insanitary conditions. Additional research work must be done before all facts and factors involved will be fully understood, but there is still a greater need for a better and more complete application of the knowledge already available in the actual practice of known sanitrary methods. May I emphasize the fact that education develops an enlightened public opinion. With this, greater progress can be made,

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resulting in a more favorable reaction in the health and happiness of everyone.

The belief that diseases are caused directly or indirectly by living micro-organisms, usually of plant origin (whence they are known as bacteria), but in some instances of animal origin (whence they are known as protozoa) is now securely established. Many members belonging to these groups of small living matter have also been found to be the agents that are the offenders in the production of putrefaction and decay.

The composition of these micro-organisms is in many ways similar to the individual cells of our own bodies. Their presence on or in our bodies or about our surroundings is our own fault. We have no one to blame if we ignore them or actually invite them through insanitary measures.

Before considering methods of eradication, let us observe the conditions which are essential for the proper growth and development of bacteria.

First.—Proper nutrition.

Second.—Presence of moisture.

Third.—Proper temperature.

Fourth.—Presence of air and in few instances the absence of the direct supply of air or oxygen.

Fifth.—Absence of direct sunlight and retarding chemicals.

All five of these are necessary. The complete absence of any one of them will reduce the activity of practically all of the bacteria, commonly found producing diseases, putrefaction, etc.

Like all plants, bacteria require food. Carbon, hydrogen, nitrogen, oxygen and inorganic salts form the basis for their food supply. In order to flourish and build themselves up, they must obtain their carbon from the complex compounds, the proteins, carbo-hydrates and fats. In this respect, they closely resemble animal life. The bacteria are provided with suitable ferments or enzymes to digest these various organic combinations. These elaborate compounds are mainly found in animal and vegetable matter, which may be clean wholesome food or the component parts of dirt, filth, etc. Bacteria are therefore dependent upon the former or latter for their nourishment.

Moisture is indispensable to the growth of bacteria. This is taken up by the cell from the moisture in the surrounding medium,

and is mainly used to dissolve the food material upon which bacteria thrive.

All bacteria require oxygen in some form in order to multiply and reproduce. Upon examination, we find that some bacteria are dependent upon the presence of free oxygen and air. They are known as Aerobes. Others require the non-presence of direct air or oxygen in order to multiply. They are known as Anaerobes. Though they do not require direct air or oxygen for propagation, it is not to be supposed that the anaerobes are not dependent upon this element for proper development. They obtain the necessary oxygen indirectly by splitting up the various organic compounds, especially proteids and carbo-hydrates.

In addition to the previously mentioned requirements, a suitable temperature is necessary for the proper growth of bacteria. Each species has a minimum, a maximum and an optimum or most suitable and best temperature at which it will develop. There is a slight variance between the suitable temperature required by micro-organisms, but as a general rule, it may be said that in the case of the parasitic bacteria (micro-organisms developing on living matter), the temperature of the living host may be considered as best adapted for their growth. Saprophytic bacteria (bacteria living on dead matter), on the other hand, develop best at a temperature of ordinary room conditions.

The maximum temperature for the proper development of bacteria is, of course, apparent, inasmuch as high temperatures will weaken the ordinary forms of bacteria. You can also appreciate that below a certain temperature, bacteria will not reproduce. Freezing over an extended period of time will destroy many bacterial species, and most all degrees of cold will prevent the multiplication of bacteria. This accounts for the cold storage as applied in our various food industries, and the ice methods, employed in keeping cadavers in those sects in which embalming is not practiced.

Bacteria develop best in dark or in diffused daylight. The direct rays of the sun weaken the bacteria and finally, in most cases, kill them.

The absence of retarding chemicals will be more thoroughly explained later.

I think you will realize that personal uncleanliness and the insanitary conditions of our surroundings (whether it is dirty or con-

taminated utensils, filthy floors and furnishings, accumulated dust and dirt, dampness, absence of sunlight, poor ventilation or foul air, or a general lack of cleanliness and healthfulness of our surroundings), are perhaps the direct factors resulting in the increase or retention of these undesirable offending organisms. To limit the chances of the spread of the latter, we must get rid of their breeding places, prevent their development, and fortify such efforts already achieved by the proper use of destructive agents.

The question which everyone has asked himself or others at some time is: "What is the best method of ridding material or environments free of organisms?"

Haphazard, arbitrary procedures have given way to scientific and precise methods. It will be impossible to cover even a portion of this most interesting topic, due to the short space of time allotted. I will therefore confine this talk to a consideration of the methods that may be used to destroy bacteria in or about the home and its environments, leaving for a later consideration the destruction of bacteria in or on the body, etc.

There are a number of terms, which are used when referring to the processes of destroying or rendering disease-producing germs harmless. These kindred terms are here defined:

Sterilization means the destruction of living micro-organisms or their removal from materials. The term is used when referring to any method or procedure by which such end result may be accomplished. It is, however, used specifically or frequently limited to the destruction of bacteria by heat.

Disinfection is synonymous with the term sterilization; but it is employed mainly to designate that process where chemicals are used as the means of ridding environments free of bacteria.

Fumigation is also synonymous with the above terms, but applied only to those procedures in which a gaseous chemical or fumes generated from a chemical or drug are employed to obtain the desired end result.

To illustrate these terms: If we were to take some wearing apparel and boil it in water or place it under the influence of steam for the required length of time, it would be best to say—we are sterilizing the clothes. If, on the other hand, the material was placed in a solution of carbolic acid or other suitable chemical, one should say, we are disinfecting the clothes. But if the material was placed

in a compartment where Formaldehyde Gas was being generated, then one should say the material is being fumigated.

The destruction or getting rid of organisms is brought about by a number of methods, which briefly mentioned are:

1. By the process of filtration.
2. By the aid of chemical agents.
3. By the use of heat.

Before entering into a consideration of the above-named methods, mention should be made of certain physical agents which exert a deleterious action upon bacteria, but which are either employed to a limited extent or not regarded by the layman as being methods of sterilization.

1. Light.

The direct rays of the sun act as powerful destructive agents for most all bacteria. The rays kill or render inert most of the commonly known bacteria in a comparatively short time. The period ranges from a few minutes to several hours, depending upon the type of organisms exposed and environmental conditions. Diffuse light will require a much longer period of time to obtain the same result. Unfortunately, some light is a variable quantity, being more or less dependent upon atmospheric and other conditions. It is frequently impossible to have materials or environments exposed directly to its actions. One, therefore, cannot solely depend upon it, but it should be employed as an adjunct to any other method that may be used.

2. Air.

"Plenty of Sunshine and Fresh Air" is the old maxim. The sterilizing quality of sunshine has been touched upon. The free circulation of pure air is very essential, inasmuch as atmospheric oxygen will dilute the bacterial content, will usually carry along the germicidal action of sunlight, and will favor drying, which in turn hastens the death of many organisms.

3. Cold.

Freezing temperatures check bacteria growth, and after a prolonged period of time, many of the organisms present finally die. Cold, recognized as a valuable and effective means of checking bac-

terial growth, is universally used by dealers in food products as a food preservative. In like manner, it is used by individuals in various professional pursuits with the same thought in mind.

The use of the previously mentioned methods is but limited, and they are at times either impracticable, inconvenient or unsatisfactory as procedures, which the housewife can depend upon to accomplish disinfection. One must therefore call upon the three practical methods, which were mentioned previously. We can quickly scan over the process of filtration, as a method of sterilization, for this procedure has but a limited use. In the application of heat or chemical agents, one aims at the destruction of the organisms. When filtration is employed, however, the removal of bacteria is accomplished without necessarily destroying the latter. The action is entirely mechanical, and this method is generally employed in the biological laboratory only for the sterilizing of those liquids which are affected by heat or chemicals.

Sterilization by filtration, as used commercially or in the home, yields a product which is rarely, if ever, bacteria free. The filters, which some laymen use in their homes by attaching them to the water tap, or the sand filters, as employed in water filtration plants, remove some bacteria, but do not yield a sterile product, as is produced when bacteriological filtration is employed with scientific exactness.

The most widely used as well as most efficient agent for sterilizing material in the laboratory, home, etc., is heat. Heat may be used in many forms.

A. Direct flame or incineration.
B. Hot air or dry heat.
C. Moist heat.

The direct flame needs little, if any, explanation, for one can readily see that, if available, this is the best procedure for the sterilization and disposing of affected materials that are comparatively valueless. All sorts of materials, as paper sputum cups, gauze, cotton and paper soiled with discharges, infected clothing, books and other materials having little value, are easily destroyed by burning. Even the sterilization of refuse and defecated material in temporary camps can be sterilized by burning or igniting them in suitable trenches made in the ground.

In the laboratory the process of applying direct fire to materials is known as "flaming." An alcohol lamp, a bunsen burner, or other devices, which will give us a non-illuminous flame, is employed. Various equipment, which would not be affected by exposure for a short time to a direct flame, can be conveniently sterilized by this process. Inasmuch as most materials in the home are likely to be affected by the high heat which is produced, other methods of sterilization are generally employed by the laity.

Dry heat or dry hot air is generally applied by means of what is known as a hot air sterilizer, which is very similar to the compartments found in the ordinary gas stoves or ovens. Articles or substances are placed in this sterilizer and allowed to remain at a temperature of three hundred degrees Fahrenheit for over an hour. This will generally kill all bacteria, but, as an efficient method, finds practical use only in the clinical or bacteriological laboratory, and is rarely, if at all, employed by the laity.

Dry heat kills bacteria due to the fact that the organisms are decomposed, or as we scientifically say, are oxidized. In the case of moist heat, the effects appear to be a direct action, either physical or chemical (coagulation and alteration upon the bacterial protein).

The action of boiling water for thirty minutes or longer will kill most bacteria, while even five or ten minutes boiling will so modify most bacteria that they will have lost their property of producing disease. This method can be used when it is desired to be assured that liquids and foodstuffs intended for human consumption are free of disease-producing micro-organisms. Water, milk, solid foodstuffs placed in water, and similar products can be boiled for at least ten minutes or preferably one-half hour. Many articles, such as dishes, glassware, rubber equipment, instruments, sheets, bed clothing, towels, other cloths and materials too valuable to be destroyed, can be and are sterilized by this method, because this is generally the most convenient and available agent.

Another method is to expose articles to be sterilized to direct steam, which attains the same temperature as that of the boiling water bath.

Subjecting steam under pressure by the use of suitable devices is a most efficient and ultimately most economical method of sterilizing many articles. Steam under pressure is the most powerful

method of ridding material free of bacteria, but inasmuch as suitable compartments or plants are required for this purpose, to be operated only by experienced workers, this method can be but rarely employed by the laity. It is only extensively used in laboratories, hospitals, clinics, detention camps and by sanitarians in general.

Fumigation.

Fumigation has been defined in a previous chapter. This method of ridding materials and environments free of bacteria was extensively used in days gone by. As an efficient method for the destruction of various insects, fumigants that are efficient insecticides are being used more frequently; but as a bactericidal agent, gases are being used to a limited extent only.

The objections to bactericidal fumigants are many, and from the viewpoint of the laity, these objections are especially true, due to the fact that the average individual is not prepared to perform the correct technique properly. It is therefore impossible to place any reliance upon this measure of sterilization, when so conducted. I might mention in passing, however, that formaldehyde gas is the most efficient and most practical bactericidal fumigant, having little or no insecticidal properties. You will find that most of the boards of health have abandoned the procedure of formaldehyde fumigation. Though almost ten years have elapsed since the leading sanitarians have advised and have taken this step, they have found no cause to change their minds, or regret the action that has been taken. I cannot be too emphatic in stating that fumigation, as conducted by the laity, especially for the destruction of disease-producing germs, is a useless expenditure of money and a waste of time. It is even worse, it is a dangerous procedure, as it creates a false sense of security, with the result that the individuals do not do that which they really should. The environments and materials from which they thought they eliminated the disease-producing organisms become in reality a greater menace than they were before.

The laity is compelled to depend extensively upon the properties of disinfectants, inasmuch as the technique for their use is simple; they are most economical; and in the hands of laymen, they are more effective than the other methods that have been outlined.

A disinfectant frequently referred to as a "germicide" or "bactericide" is a chemical or a drug or a solution of these, that will

destroy micro-organisms or render them harmless. Disinfectants may or may not act as insecticides, that is, kill insects. They may or may not necessarily be deodorants, that is, remove impure or obnoxious odors.

An antiseptic differs from a disinfectant in not killing the organisms present in a given substance, but merely stopping or preventing the further growth and development of these organisms.

A "bactericide," if diluted sufficiently, will only act as an antiseptic (*e. g.*, 5 per cent. solution carbolic acid is bactericidal, one-half per cent. solution is only an antiseptic).

Not all antiseptics can be concentrated sufficiently to act as bactericides, as, for instance, Benzoate of Soda, Boric Acid, Peroxide of Hydrogen are only antiseptics and never in themselves become bactericides. It is evident that the use of disinfectants in the prevention of decomposition or as an aid in general sanitary measures is a very large subject. You will also be able to observe shortly, that no one disinfectant can be regarded as the ideal one and to be employed in all cases.

To consider all of the disinfectants would require days of discussion. I will therefore attempt to cover merely the important characteristics to be considered during practical disinfection, and mention the most important disinfectants which may be employed, and are typical of the class of "General Disinfectants." At a future occasion I will attempt to bring to your attention the disinfectants that have more specialized and specific uses.

May I first bring to your attention a number of simple yet important regulations, which must be observed at all times, when using a chemical or a chemical solution, as a disinfectant.

Be Sure

1. That the chemical has been proven to be a disinfectant.
2. That the chemical will not be changed into an inert substance, when coming in contact with the material you are about to disinfect.
3. That a sufficient quantity of the disinfectant is used. (By merely throwing a drop of a diluted phenol solution in a sample of sputum does not say that the latter will be disinfected.)
4. That the germicidal agent will come in direct and intimate contact with all of the bacteria.

(Floating a germicidal solution over a liquid to be rid of bacteria is not sufficient. It is necessary to shake the mixture thoroughly, so that the bacteria will be placed in direct contact with the disinfectant.)

5. That the disinfectant will remain in contact with the bacteria for a sufficient length of time to exert its action.

(Dipping contaminated clothing in a disinfectant solution for a few minutes and then removing the material will not kill all the bacteria. At least fifteen minutes or even a longer length of time is necessary, depending upon the chemical solution used.)

With very few exceptions, faulty disinfection and poor results can always be found to be due to carelessness by not considering one of the foregoing rules. There are other factors that influence the use of one chemical instead of another:

1. Low cost (compound solution of cresol is to be preferred to carbolic acid because it is cheaper and a more effective disinfectant).
2. Ready solubility or miscibility with water or commonly employed solvents. (Compound solution of cresol, containing 50 per cent. cresol is to be preferred to a mixture containing 75 per cent. cresol in kerosene, due to the fact that the latter is immiscible, while the former is miscible with water. A kerosene preparation of cresol will not kill bacteria in a mass, because it will not mix with the water on the material, where the micro-organisms are present.)
3. Should not be toxic to both man and animals, and should not bleach, tarnish or otherwise affect the furnishings in a household or material to be disinfected.
4. Temperature that can be used. Warm solutions of chemicals are more effective disinfectants than cold solutions.
5. A chemical having a great penetrating property and requiring but a short period of time for disinfection is to be preferred.
6. A stable compound both under ordinary conditions, or when employed as a disinfectant.
7. Should not possess a disagreeable odor.

In this country, an act, known as the Insecticide Act of 1910, was adopted for the purpose of preventing the manufacture and sale of adulterated or misbranded insecticides and fungicides. The Insecticide and Fungicide Board of the Department of Agriculture has been vested with the power of regulating the traffic in disinfectants and germicides, and it may be pointed out here, that they have within recent years ruled that a disinfectant insoluble or immiscible with water, or one that loses its strength and germicidal efficiency, when coming in contact with organic matter, should not be termed a disinfectant for general use.

The actual changes taking place when disinfectants are used for the destruction of bacteria are not clearly understood as yet. Some seem to act by penetrating the cell wall, and enter the cell proper and there exert a toxic action (Ex. Dilute Alcohol). Others act as dehydrating agents, withdraw moisture from the individual cells, and the latter subsequently die (Ex. Absolute Alcohol). In some instances, there is a quick coagulation of the cell protoplasm or the formation of an insoluble and impenetrable substance, which prevents nourishment from gaining entrances, and the bacteria eventually die (Ex. Formaldehyde). Again there are those chemicals that, by rapid oxidation, cause a destruction of the bacterial cell (Ex. Peroxide of Hydrogen, Permanganate of Potash, etc.).

Chemical germicides may be used dry (as iodoform), in solution (Bichloride 1:1000), or in a gaseous state (formaldehyde). The number of chemical agents having destructive action on bacteria is very large. Each possesses its own particular usefulness, and due to such individual characteristics, each is more or less ideal in its own field.

I will first consider the disinfectants, which have been extensively exploited, or otherwise recommended by laymen to laymen, and which either have a limited use or are dangerous substances to include with the more important commonly used disinfectants which will be discussed lastly.

Bichloride of Mercury.

Bichloride of Mercury, known also as Corrosive Sublimate and Mercuric Chloride, is an extremely poisonous chemical, the sale of which is generally regulated by law. Though one of the most powerful disinfectants known, and employed extensively for medical and

surgical applications, it has but a limited use as a general disinfectant in the home, due to the following disadvantages it possesses:

1. Highly poisonous. Cannot be used in containers used for foodstuffs, etc.
2. It fixes stain in soiled fabrics.
3. It is precipitated by soap, and sulphur compounds.
4. It coagulates albumen and accordingly cannot be used for the disinfection of feces, sputum, pus or any other material containing protein. An insoluble coagulum of albuminate of mercury is formed, which has little or no disinfecting properties, and which prevents further penetration of any excess of Bichloride of Mercury that may still be present.
5. It is injurious to metals. Therefore never use Bichloride of Mercury for the disinfecting of metallic instruments.

This disinfectant is usually sold in the form of tablets, which, when dissolved in a stated amount of water, will yield a solution which is bactericidal. The only convenient use of this solution as a household disinfectant is for the disinfection of contaminated clothing, bed linens and similar materials in a sick room by keeping the latter therein for one hour and then washing and laundering.

Formaldehyde.

Formaldehyde is marketed in two forms. One which is sold in compressed form as a powder is used as "Paraform" or "Solid Formaldehyde," a term which is erroneously applied. A solution of Formaldehyde gas in water, sold under the name of "Formalin" or "Solution of Formaldehyde," is more extensively employed, either in its liquid state, or as a medium from which the gas may be liberated.

Gaseous Formaldehyde, obtained by heating solid Formaldehyde or from the solution in water, is the most efficient, as well as the most practical bactericidal fumigant, and should be the only gas to be employed when the object of the fumigation is to get rid of bacteria. This vapor, however, has no insecticidal value. Inasmuch as I have expressed an opinion that fumigation generally in the hands of most laymen yields unsatisfactory results, I will not consider at this time the exact technique which one should employ during For-

maldehyde Gas fumigation. The liquid, which contains from 37 to 40 per cent. Formaldehyde gas in water, is in itself a reliable disinfectant, when employed in a dilution of one or two volumes of solution in nineteen volumes of water, using an exposure of one hour. This solution has the advantages over bichloride, in that it is not highly poisonous, non-corrosive, non-injurious to even delicate fabrics, not affected as readily by organic matter, and in addition is a very efficient deodorant. I personally have never recommended Formaldehyde Solution to any great extent as a general disinfectant to be employed by the layman, unless the disinfection is to be done in an environment and at a time where humans will not be found constantly. The liquid has a pungent odor, and the vapors which are liberated, because the gas is volatile, are irritating to the mucous membrane of the eyes, nose and throat. Also, if there is sufficient heat about, there may be enough of the gas liberated, leaving an amount of disinfectant in the material that is being treated which may not necessarily kill bacteria in the given hour time, which is generally specified.

Chlorine and the Hypochlorites.

There are many commercial preparations marketed which depend upon *Chlorine* for their bactericidal efficiency. Many attempts have been made through advertising campaigns to introduce and popularize these chlorine products as general disinfectants. For such general use, the well-known liquids—Labarraque's Solution or Javelle Water, and the powder Chlorinated Lime, which can be bought in the corner store, will be found as efficient as any of the advertised chlorine products. The use of chlorine preparations for general disinfection is, however, restricted. They all leave an objectionable odor, are powerful bleaching agents, corrode metals, are easily decomposed when coming in contact with organic matter, quickly lose their strength if left uncovered, and a fact that is perhaps very important but not mentioned by the manufacturer, the chlorine preparations will not destroy the tubercle bacillus.

As a disinfectant and deodorant, for the chlorine preparations are powerful deodorants, the application of the latter is limited to the treatment of refuse, sick room discharges, manure, etc., outside of the home, or around privies, stables, barnyards or in environments that may not be affected by the odor and the other undesir-

able features. A satisfactory dilution is to use about five ounces of the above-mentioned product in each gallon of water.

In preparing the latter dilution, if the powder is employed, best results may be obtained by first rubbing up well the chloride of lime with a little water, as in making a flour paste, and finally adding enough water to the desired volume. In applying this solution to sick room dicharges, etc., it would be advisable to add at least volume for volume to the discharges, etc., and then add a little excess amount, so as to allow for the loss of chlorine decomposed by the organic matter. The only place where the writer would feel free to recommend either a solution of Chlorinated Lime or any of the other Chlorine compounds, as a desirable disinfectant, in the home, in preference to other disinfectants, would be in the cleaning and disinfection of empty ice-boxes, refrigerators, vats, casts, etc., providing that these would be lastly washed with hot water or steamed out, so as to get rid of any traces of Chlorine that may remain.

Carbolic Acid.

The term carbolic acid has unfortunately been employed rather loosely by the laymen, and many preparations that are closely related have been at times erroneously designated under this heading.

Carbolic acid, or phenol, as it is more properly termed scientifically, was discovered in 1834, and was thought to be the same as Wood Creosote, then regarded as a very valuable disinfectant, especially for the preservation of timber. This was soon found to be incorrect. Creosote, though an important disinfectant, is insoluble in water, coagulates albumen, and as such is rarely employed, today, as a general disinfectant.

Phenol in its pure state is a solid at ordinary temperatures, occurring in large masses of long white needle-shaped crystals, which assume a reddish tint upon ageing. By adding one part of water to each nine parts of crystal, liquid carbolic acid or liquid phenol is the result. This is what is usually obtained in the drug store, when carbolic acid is ordered. A 5 per cent. solution of the latter is a very satisfactory general disinfectant, having a wide range of usefulness. An equal volume added to urine, feces, sputum and other excretions, mixed thoroughly, and allowed to stand for at least one hour before final disposal, will insure the destruction of bacteria, that may cause disease. In a solution of that strength or even one-

half the strength mentioned, floors, walls, etc., may be mopped. Soiled linen, bed clothes, fabrics, metallic instruments, etc., may be immersed in such solution for one hour to insure disinfection.

It should be remembered that a solution of Carbolic Acid is highly poisonous, and care should be observed in keeping it about the home. Other than this, phenol has been found inefficient in its attempt to destroy the causative agents of Anthrax, Tetanus and those diseases in which the etiological factors are highly resistant. It is also very expensive and for the previous stated reasons is not recommended as highly as the so-called coal tar disinfectants that are to be mentioned later.

Crude Carbolic Acid.

In certain quarters, the laity seems to demand the so-called Black Carbolic Acid in preference to the White Carbolic Acid, which was previously discussed. This substance is not carbolic acid, but a mixture of chemicals, closely related to pure carbolic acid, together with other substances referred to as the Coal Tar Oils. It is not as efficient as phenol, leaves a disagreeable odor and an objectionable residue. When diluted, it is only efficient if a 5 per cent. solution is mixed together, preferably with a little heat, with an equal volume of a 5 per cent. soft soap solution. Such an emulsion is practically similar to the emulsified coal tar disinfectants, which can be bought on the market in a concentrated form and a purer condition.

Coal Tar Emulsions.

In days gone by, bituminous coal was heated by a special process (known as destructive distillation) so as to obtain the residue which, known as coke, a fine form of carbon, was to be employed in the manufacture of steel. The other substances, known as by-products, produced during such distillation, were thrown away. This comprised especially a liquid which possessed a disagreeable odor and a characteristic black tar appearance. Today, the latter rather than the residue, is mainly sought in the treatment of bituminous coal. By special processes of heating, known scientifically as fractional distillation, many different liquids are obtained from the coal tar liquid. Many of these are closely related to carbolic acid or phenol, and though they possess specific names, as cresol, etc.,

they are frequently grouped under a general heading, known as Phenols. May I impress upon you that the so-called phenols (general term) differ in many respects from Carbolic acid or phenol (specific term). This is almost similar to the term Alcohol, as employed by the chemist. The latter term is used specifically, when referring to grain or ethyl alcohol, but also is employed in a general sense, when referring to a group of closely related chemical substances, and thus we have wood or methyl alcohol, glycerine or glyceryl alcohol, etc.

With few exceptions, the active phenols or disinfectants in this coal tar substance are all liquids, and are but slightly soluble in water. On this account, they usually require a solvent or other carrier to bring them into a condition so as to make them soluble, and thus exert their activity more readily. Soap (both hard and soft) is mainly employed as the vehicle for the so-called coal tar oils. It acts as an efficient emulsifier of these products, forming such combinations, which are readily soluble in or miscible with water. The end preparation is generally referred to as an emulsified coal tar disinfectant. Because of the presence of the soap, they possess a cleansing, as well as the additional germicidal property.

As a class, these coal tar disinfectants are active germicidal agents and deodorants, cost less than most of the other disinfectants, and where the slight odor is not objectionable, they are to be preferred to any of the other disinfectants herein mentioned. In the dilutions commonly employed, they are non-toxic, non-irritating, non-corrosive and do not have their efficiency lowered by the presence of albuminous or other organic matter.

Compound Solution of Cresol (U. S. P.).

Compound solution of Cresol (U. S. P.) (similar to Lysol, etc.), is representative of the so-called soluble coal tar disinfectants, and made with soft soap as a base. Creolin is a type of the emulsifiable coal tar preparations, which form a milky suspension, when mixed with water. There apparently seems to be no material difference as far as the bactericidal efficiency is concerned between these two types, though at one time it was thought that preparations of the latter type were more efficient.

The coal tar disinfectants differ among themselves as far as their relative germicidal efficiency is concerned. This is because of

the different kinds of oils, and the different methods of preparing these products, so as to obtain a substance soluble in or miscible with water. It is almost impossible to determine the exact nature of phenols present in such an endless variety. And even if such procedures were at all possible, the germicidal value of the particular preparation would still be unknown. Many attempts have therefore been made by bacteriologic methods to determine the germicidal value of disinfectants, and develop a possible means of standardization. Numerous procedures and methods of technique have been introduced, but it is evident that none are recognized except "The Phenol Co-efficient Tests."

The bactericidal value of Phenol or Carbolic Acid, recognized as an efficient germicide, is taken as unity. The germicidal value of any other chemical is determined by actual comparison with phenol. Both are tested under identical conditions, using the TYPHOID BACILLUS as the test organism. By observing the dilutions of the samples which are as efficient as given dilutions of phenol, a ratio of the germicidal power of the disinfectant compared to the germicidal power of phenol can be obtained (especially so, inasmuch as both disinfectants were tested under identical conditions). The ratio is expressed in what is known as the "Phenol Co-efficient." This is a numerical figure, which indicates how many times more or in some cases less is the bactericidal efficiency of a particular disinfectant as compared with phenol. From the known phenol co-efficient, one can quickly determine the dilution of a disinfectant, which still will retain the equal germicidal value as a stated phenol dilution.

The United States Government does not compel the labeling of a disinfectant with its phenol co-efficient, but through the fungicide and insecticide board, they do compel a manufacturer to market his disinfectants to be of the particular co-efficiency, as shown on their labels, if a stated phenol co-efficient is given. There are, however, certain states in the Union that compel manufacturers to state the phenol co-efficient of their disinfectants on the label before they can be sold. Maryland was the first state to adopt such a law.

At first thought, one can easily see the advantages in a phenol co-efficient. A figure is at once available which will show the comparative strengths of the many disinfectants. But the tests are after all only relative, and it is a known fact that the conditions imposed upon the laboratory tests are not identical with the action of the

disinfectant in practice. As has been shown by many workers, the phenol co-efficient is almost worthless as a comparative figure to determine the disinfecting value of chemicals of a different nature (*i. e.*, different chemical composition).

In a modified way, this test is somewhat satisfactory as a figure for comparison of the coal tar disinfectants. Even here some discrepancies exist. I feel that the phenol co-efficient should be used for coal tar products only, until such time that better methods of determining relative values of disinfectants will be devised.

As a safe dilution of all these coal tar emulsifiable disinfectants, two ounces of the product to each gallon of water will be usually of sufficient strength to give a dilution which will be an active germicidal agent. It can be used to advantage in the disinfection of floors, walls, metals, linens, clothing, discharges, etc., and if the slight characteristic coal tar odor is not objectionable, its use can be extended to disinfect almost anything, except foodstuffs. It is my personal feeling that the slight characteristic odor is really desirable and not objectionable, for one can thus quickly tell that disinfection was conducted in a particular environment; and may we be frank to also admit that the psychological effect is at times to be desired.

You and your dear ones are frequently dependent upon each other for your health and protection against disease. If the facts related to you this evening were generally considered, appreciated and correctly applied, you and the community at large would profit thereby. Intelligent thought, greater interest and a closer intimacy with this important topic will be found to be worth while, the end result yielding an assurance that close attention to little things is rewarded with notable returns.

A Venerable Journal.—With the issue for January 1, 1925, the *Journal de Pharmacie et de Chimie* begins its eighth series, and enters on its one hundred and sixteenth year of uninterrupted publication. It appeared only once a month in the earlier period and was in part the channel of publication for the proceedings of the Société de Pharmacie. The current issue contains a summary of the papers appearing in the issue of January 1, 1825, that being the eleventh year of the publication. Articles on croton oil and on the composition of borates are noted among others. H. L.

AIMS AND DEVELOPMENT OF THE MEDICINAL AND POISONOUS PLANT INVESTIGATIONS GARDENS, SOUTH DAKOTA STATE COLLEGE, DIVISION OF PHARMACY.

Anton Hogstad, Jr., P. C., M. S.

PART I.

Introduction.

The fifteenth day of February, in the year 1558, marked the passing of one, of but many, to whom we, the present recipients and trustees of the time-honored profession of pharmacy, are wont to give but a fleeting note of recognition and due respect.

Francesco Buonafede, an Italian physician, represents but one of countless of these interesting personages of the past, to whom we are deeply indebted for the many privileges that we are daily receiving, in the name of the profession of pharmacy. Buonafede was honored by being appointed the first Professor of Pharmacognosy and who was also responsible for the establishment of the first botanical garden,* which provided for a collection of medicinal plants to be used for instructional purposes.

It matters not, in these busy days, whether it be in the realm of pharmaceutical instruction, where one is daily confronted with the crowded classroom, voluminous text and reference books of one sort or another, tests and examinations, or whether it be in the retail field, where one is wont to hear the ever-familiar click of the cash

*Quoting from Arthur W. Hill, "The History and Functions of Botanic Gardens," Annals of the Missouri Botanical Garden, Vol. II, Nos. 1 and 2, pp. 185-240, 1915, "This garden is of especial interest, as not only have we an excellent account of it written by de Visiani (Dell' origine ed anzianita dell' orto botanico di Padova, Padua, 1839; Saccardo, P. A. L'orto botanico di Padova nel 1895, pl. 1-8, f. 1. Padua, 1895), but also because it is preserved very largely in the original condition. The circular wall by which it is enclosed, though not the original one built in 1551, occupies the same site, and was rebuilt between 1700 and 1707; within the wall the garden is laid out in numerous little beds with stone edgings. The garden underwent many vicissitudes and fell into considerable decay, but in the year 1837 it was thoroughly restored, and the arrangement of the beds may well be a restoration of the original condition of the garden. In any case it affords an excellent example of the type of geometrical garden illustrated in horticultural books published at the end of the sixteenth and beginning of the seventeenth centuries, which for so long a time dominated garden design on the Continent.

"It is to be regretted that the principal features have been somewhat obscured by the growth of trees, but the ground plan fortunately remains unaltered."

register, thoughts of rapid turnovers, systematic methods of drug store merchandising, inventories and the like, we, of this busy day, are too prone to say to ourselves, that the present is here, and so why deal with that which has passed.

If we would but stop and reflect for a moment or two during the course of, or at the close of these busy days, we would come to the realization that the present generation is but simply expending the interest fund that has been accumulating, which fund was cre-

PADUA BOTANIC GARDEN.

". . . In this garden, Buonafede arranged the first collection of drugs, "Spezieria," for purposes of instruction, in which the crude products from the Levant were preserved, in order to employ them as standards for the discrimination of pure and adulterated articles."

(Photograph of plate in A. W. Hill's "The History and Functions of Botanic Gardens," Annals of the Missouri Botanical Gardens, Vol. II, Nos. 1 and 2, 1915.

ated by the investment of the principal that was established by the founders and early developers of our profession.

Many of them devoted their lives to the establishment of this noble cause . . . the endeavors of whom represent the principal just previously mentioned. Without this principal . . . the foundational stones of our profession . . . we of today would not be reaping the many benefits that come to each of us daily.

It is true that a strange transformation has come over the profession of pharmacy, in which we note the passing of the old

rhizotomist and herbalist, as well as the bearded apothecary and his quaint shop around the corner, and in whose shop many strange and mysterious herbs, barks, roots and insects were daily dispensed for the relief of the ills of mankind.

The use of medicinals for the treatment of the ills of mankind, is subject to various repetitive cycles of prominence, and today we are beginning to think in terms of the colloid, which thought if properly developed, as no doubt it will be, will not only give prominence to such substances as colloidal gold, silver, arsenic, iron, etc., but which will bring us face to face with the utilization of the crude vegetable and animal drugs, in terms of colloidal behavior.

However, in the light of modern therapeutic thought, we will approach the future problem in a far different manner, than did the early rhizotomists and herbalists.

Rational therapeutics has, during the years that have passed, largely replaced empiricism, although we still cling tenaciously to many empirical practices, and will beyond a doubt continue to do so in the years to come, for it is a difficult matter to change the very nature of man.

Chemical pharmacology—the relationship of chemical structure to physiological action—will also play an important part in therapeutic thought of the future. We are but on the threshold of this vast field of investigation, all of which must necessarily be taken into account by the pharmacognocist.

If the above-mentioned changes are to be brought about in the future, then there will needs be a thorough reinvestigation of practically our entire vegetable and animal materia medica, for the investigations of the past, recorded in literature, were conducted for the most part upon unauthentic, (?) improperly dried and preserved materials, which findings will not, in the light of our present trend of therapeutic thought, represent the true activity of these drugs. No matter what the changes may be, we will again find ourselves in the footsteps of Buonafede, Galen, Martius and others, in the return to the crude vegetable and animal drugs.

So, as one browses through the dust-covered books in the archives of pharmacy, one comes to the realization that the work accomplished in the past, even though it may be largely empirical in its general make-up, is an all-essential, and of especial value, for the problems that confront us today, and will also stand us in good stead for the interpretation of what to expect on the tomorrow. We

cannot, and we must not, be neglectful of the fact that empiricism has taught us a great deal, for much of the knowledge that we possess concerning the drugs in daily use, has been handed down through generation after generation through this quaint and irrational practice.

To return again to that interesting personage, Francesco Buonafede, we are told by Flückiger and Tschirch, in their valuable work, "Principles of Pharmacognosy" (English translation by F. B. Powers, 1887), that the chair occupied by Buonafede as the first professor of pharmacognosy, was that of "Lecturam Simplicium," and which was founded by The Signoria of Venice, in her university at Padua, in the year 1533. Buonafede later distinguished himself by the development of this garden, which was made possible through a resolution passed by the Venetian Senate and carefully provided for by this body. The tract of land, which is in sight of the magnificent cathedral Sant' Antonio in Padua, was given by the Benedictine Convent. Buonafede arranged in this garden the first collection of drugs, "Spezieria," for purposes of instruction, in which the crude products from the Levant were preserved, in order to employ them as standards for the discrimination of pure and adulterated articles.

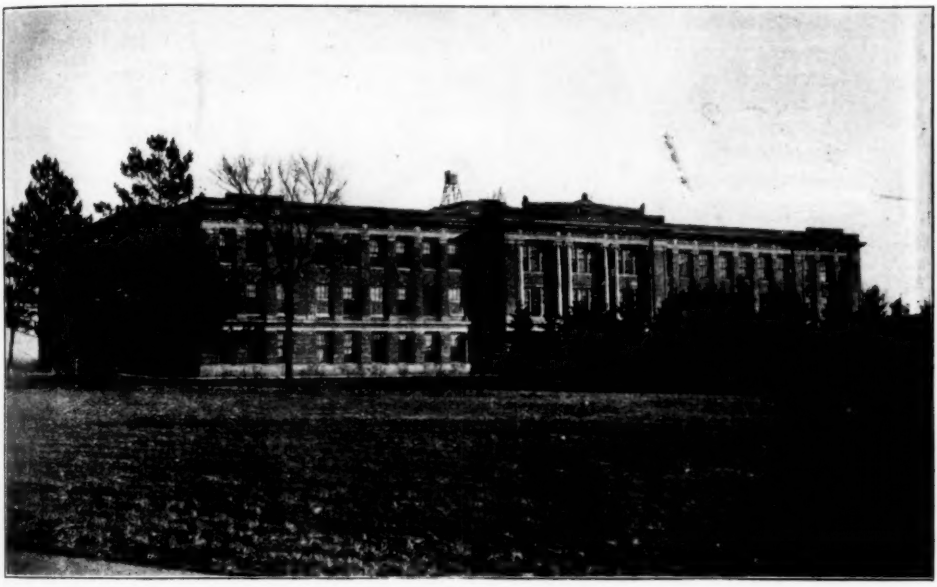
Through some mishap of Fate—such as often comes to those who devote their lives to some noble cause—Buonafede, at the age of seventy-six, lost his position. He later became blind, and died in penury in the year 1558.

Many reasons can be advanced as to the underlying motives that prompted the establishment of the Medicinal and Poisonous Plant Investigations Gardens at the South Dakota State College, Division of Pharmacy, in the spring of 1918. These gardens to date have passed through seven years of activity, and are today recognized, not only as an integral and valuable adjunct to the Division of Pharmacy, but also as a permanent feature of State College.

The prime motive, however, responsible for the establishment of these gardens, whether it be considered in a direct or an indirect manner, was for the preservation, if but in a small measure only, of the treasured heritages of the past, as they relate to these interesting personages who founded the profession of pharmacy. Then also their establishment is a tribute to the many silent gifts of nature, which have been utilized since prehistoric times, either for the cure—the relief—or for the consolation of mankind during periods of bodily distress.

Dedication.

Therefore, as a token of esteem and respect as well as due appreciation for the efforts recorded in the historical treatises relative to the professions of medicine and pharmacy, in behalf of Francesco Buonafede—the first professor of pharmacognosy and the first to establish a medicinal plant garden for instructional purposes—the Medicinal and Poisonous Plant Investigations Gardens, of the Divi-



ADMINISTRATION BUILDING.
South Dakota State College Division of Pharmacy Occupying North Wing on Main Floor.

sion of Pharmacy, South Dakota State Coilege, are herewith respectfully dedicated to the memory of this lover of medicinal plants, and to his many silent friends, nature's gifts to mankind.

PART II.

Early Development.

The first garden of a medicinal nature to be established at the South Dakota State College was that developed by Miss Charlotte Elliott during the summer of 1914. Miss Elliott was at that time instructress in the department of botany, which department had charge

of the work in pharmacognosy as offered to the student enrolled in the department of pharmacy.

Miss Elliott succeeded in cultivating a number of medicinal plants, *e. g., Datura Stramonium, Hyoscyamus niger, Digitalis purpurea, Helianthus annuus, Ricinus communis,* etc. The garden was arranged in series of rows, allowing for open field cultivation. A number of the plant products were harvested that fall and utilized in connection with the course in pharmacognosy.

The work was discontinued at the close of that summer, and was not resumed again until the spring of 1917, at which time Professor Serles, at that time assistant to the late Professor Bower T. Whitehead, conducted some germination work in the greenhouses of the department of horticulture. Owing to the death of Professor Whitehead, April 1, 1917, Professor Serles was obliged to accept the responsibility for the successful completion of the collegiate work, for the remainder of the year, which duties necessarily meant a discontinuance of the medicinal plant project.

The writer, upon assuming his duties in connection with the South Dakota State College in the fall of 1917, was informed that among his varied duties would be that of the establishment of a medicinal plant garden as soon as circumstances permitted this.

Sketches of various types of ornamental gardens were prepared during the winter months of 1917-1918. It was deemed advisable, then, that the gardens should be of an ornamental type, for it was quite apparent at that time that an ornamental drug garden, as an adjunct to a school of pharmacy, would serve well as an important publicity agent. As will be discussed in another part of this paper, the gardens have been the means of much publicity and favorable comment during the past seven years, which was largely brought about by the fact that they were ornamental in design, all of which has had an important bearing on the present state appropriation that the Division of Pharmacy is now enjoying.

As days and months passed, it was found that the preparation of a blueprint was quite a different problem as compared to the actual carrying out of one's plans, for in the first place, the great difficulty to be encountered, was that of securing a suitable plot of ground for the proposed gardens. Upon inquiry it was found that all of the land, on or about the immediate vicinity of the campus, was being utilized for other forms of experimental work, such as agronomy, horticulture, etc.

Those who have been directly responsible for the establishment of the drug gardens, in connection with our schools and colleges of pharmacy throughout the country, have been, no doubt, in many instances confronted with a similar proposition, for the beginning of a drug garden is looked upon with some little suspicion, as well as a project, which in all probability would be incapable of yielding returns commensurate with the time and funds devoted to same, as compared to the more common and firmly established lines of plant cultivation experimentation. As was to be expected, those in charge of the various experimental plots were not prone to sacrifice any

GARDEN OF MANY HERBS.

The Medicinal and Poisonous Plant Investigations Gardens. Founded 1918.

Although the location was undesirable in many respects, the gardens created quite a favorable impression and fulfilled their greatest purpose . . . that of paving the way for the present Medicinal and Poisonous Plant Investigations Gardens.

of the land devoted to their particular problems for a project which had up to that time almost been unheard of in a general sense.

With this obstacle to contend with it was soon realized that the next best move would be to secure any plot of ground whatsoever, in order to make a start in this direction, and to trust to whatever favorable publicity and comment which a garden of this type might be able to create.

Through the kindness on the part of Dr. N. E. Hansen, who saw the potential possibilities of a drug garden, a small plot of ground was granted the School of Pharmacy, this plot lying adjacent to the college heating plant. A goodly portion of this plot of ground

was cut away by a road leading to the heating plant. The site was far from being desirable in many respects, for it was subject to the various nuisances of a heating plant, *e. g.*, ash dump, exhaust pipes, etc. Furthermore, there was an additional road to the east, so that the plot was completely surrounded by the combination of roadways and the ash dump. However, in full realization of these insurmountable difficulties, the plot, and as much of the immediate surroundings as possible, were given a thorough overhauling, and a blueprint prepared. The sketch called for some nineteen beds, interspersed with cinder walks, all of which in turn were surrounded by four-foot border beds. The width of the beds was set at six feet, for purposes of easy cultivation, regardless of weather or soil conditions.

During the fall of 1917, the writer visited the University of Minnesota College of Pharmacy and through the kindness and generosity on the part of Professor E. L. Newcomb, a number of seed and plant materials were secured. To this collection were added numerous other materials by Dr. W. W. Stockberger, physiologist in charge of drug, oil and poisonous plant investigations, Bureau of Plant Industry, Washington, D. C., who is responsible in a large measure for the successful development of our present gardens, as well as many of the other medicinal plant gardens throughout America.

The 1918 plantings of course were not as extensive as the plantings of later years, but which included a fair representation of medicinal plants. By a daily, and an almost constant application of water, the plants were maintained throughout the 1918 season, in opposition to the heat and dust from the adjacent heating plant. Practicaliy all of the materials succeeded in making a fair showing, the materials being collected that fall for laboratory work in pharmaceutical botany and pharmacognosy. Some forty pounds of Digitalis leaves and twenty-five pounds of Belladonna leaves were harvested and properly dried from the 1918 plantings.

A small plot of ground was set aside in the college grove for such shade-loving plants as *Podophyllum peltatum, Sanguinaria canadensis, Cypripedium pubescens, Hydrastis canadensis,* etc., but which failed to thrive to any marked degree, owing to poor soil conditions.

Although the gardens in general produced but a small amount of materials, they did, however, fulfill that which was most desired,

namely, that of creating favorable comment and publicity. With this fact established, the opening wedge had been driven for a more suitable site, and at the close of the 1918 season, the School of Pharmacy was offered the ground now occupied by the present Medicinal and Poisonous Plant Investigations Gardens. Only a small portion of the present site was given to the School of Pharmacy at that time, but since then the gardens have gradually expanded and at the present time occupy the entire acre plot, which is ideally situated as to character of soil, drainage, as well as being close at hand.

". . . As one meanders amid these quaint herbs, many of which have been named in honor of the Founders of our Time-Honored Profession . . . one is brought to a fuller realization of the Great Service that has been rendered by these many interesting personages of the past."

Period of 1919-1924.

In the spring of 1919, work was started on the preparation of the new gardens, which plot had been devoted to some experimental work in alfalfa, nursery stock, and in addition a vegetable garden.

The first section of the plot to be developed was that of the present "Garden of Many Herbs," in which at the present time some 200 to 250 different varieties of medicinal plants are placed under cultivation, in small amounts. This garden is of an ornamental type, consisting of a series of well-arranged beds, interspersed by grass walks, all of which surround the fountain and pool. In addition,

the other main features of the garden are the pergola entrance, miniature fountain and bird bath and the series of distinct and unique plant labels. This garden is completely surrounded by a hedge of Siberian Pea plants. The plot measures 64 x 100 feet, with a six-foot border bed directly inside of the Siberian Pea hedge. The grass walks were introduced to eliminate the many detrimental influences of cinder or gravel walks, *e. g.*, excessive heat radiation, dust, weeds,

THE MEDICINAL AND POISONOUS PLANT INVESTIGATIONS GARDENS.

Left (background). Two plots for Insect Flowers and Belladonna respectively (1924).

Left (center). Garden of Many Herbs, in which some 200-250 species and varieties of medicinal and poisonous plants are placed under cultivation annually.

Left (foreground). Floral Gardens, under the direction of Professor P. Keene of the Department of Horticulture.

Right. American Wormseed Herb (1921-22-23-24).

Photo July, 1924.

etc., and on the other hand to add to the gardens a touch of beauty and softness of tone. Walks of this type entail considerable additional labor, in order to keep them properly trimmed, and as commonly expressed "to keep them from wandering all over the gardens." This latter difficulty is overcome by having the freshman class in pharmacognosy apply themselves in a practical manner dur-

ing one laboratory period in the spring. During this time the various beds are spaded, walks trimmed and the gardens cleaned up in general. A set of stakes are placed at inconspicuous places under the hedge, from which lines are thrown, marking the edges of the walks, in all four directions. The stakes are a permanent feature of the gardens, and help to elimlinate a great deal of difficulty every year.

As stated above, the gardens have gradually increased in size until they now occupy the entire acre plot, and in addition another acre was utilized for the 1924 American wormseed plantings.

The gardens proper on the one-acre plot are enclosed by a neat wire woven fence attached to concrete posts, outside of which an eight-foot grass boulevard extends around the entire garden.

This plot is subdivided as follows: (1) Garden of Many Herbs; (2) Floral Gardens (under the direction of Professor Keene, of the Department of Horticulture); (3) two experimental plots, being devoted during the 1924 season to the cultivation of Belladonna and the other to the Insect Flowers; (4) open field cultivation plot, which has been utilized during the past three or four years for the cultivation of the American Wormseed.

The floral gardens were introduced as an attractive feature to the gardens in general, as well as allowing some space for floral-culture studies by the department of horticulture.

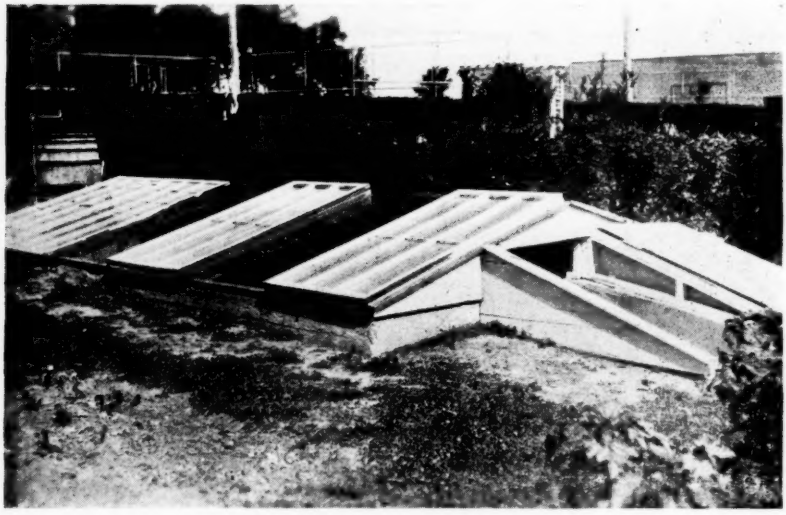
Two signs, measuring 4 x 6 feet and properly mounted, designate the gardens as those devoted to the cultivation of medicinal plants, placed at opposite ends of the gardens.

During the spring of 1924, a cold frame of wood and concrete construction, was added to the gardens in order to provide space for the young seedlings after they are removed from the greenhouses, preparatory to open field transplanting. This frame measures 9 x 18 feet, and is provided with six double strength glass sash, an entrance at the east end, and a trench eighteen inches wide and two feet deep, running the entire length of the house, the latter eliminating the many difficulties encountered in having to stoop in a frame not provided with this convenience.

Water is piped directly into the house by first being run into a barrel on the outside; the water is then warmed by heat of the sun's rays, before applying to the delicate seedlings.

All materials in the gardens are properly labelled by a series of several types of plant labels. Possibly there is no other feature of a

garden which causes more concern than that of the designing of a suitable label. This difficulty has been overcome in part by the adoption of several different types of labels. Every batch of plants set out in the gardens, is first provided with a metal name plate and number, on two separate labels, these being attached to a looped metal rod, three feet in length. In addition to this type of label, the plants in the Garden of Many Herbs are provided with another label, designating the scientific and common names, habitat, part used, and general medicinal action. This label consists of a hand-



A SERVICEABLE COLD FRAME.

In the ordinary type of cold frame, one encounters considerable difficulty in having to "stoop," which in the above cold frame has been eliminated by the side entrance and an 18 in. x 24 in. ditch running entire length of frame. Water is supplied to the house direct, by first having same run into a barrel on the outside to become "warmed" by the heat of the sun's rays.

lettered metal plate, attached to a bevelled board, which in turn is attached to a wooden stake. A label of this type makes the gardens a source of interest and one of value at all times to the visiting public. In addition, different sizes of the ordinary pot labels are utilized as well as the stake label for the open field plantings. The metal label is ideal, in that same can be left in the gardens throughout the entire twelve months, without becoming destroyed.

To provide a good setting for the gardens Castor Beans and Indian Hemp are planted every three feet apart, around the gardens,

directly inside of the wire woven fence, setting the gardens aside as a distinct unit.

Part III.

Is a Medicinal Plant Garden Essential and Worth-while?

Several excellent papers have appeared from time to time in the pharmaceutical press, expressing many good thoughts in answer to the question, "Is a Medicinal Plant Garden Essential and Worth-while?" It is not the intention of the present writer to make a series of statements to the affirmative, but rather to point out from personal experiences extending over seven seasons of garden experience, a few of the many benefits to be derived from such a garden.

(a) *A Living Laboratory.*

The writer thought it might be of interest to include in this paper the definition of the position occupied by the gardens, from the viewpoint of the administration, as they relate to the Division of Pharmacy as a whole. This question has been discussed more or less with Dean E. R. Serles during the course of the past seven years in a general manner, but in order to obtain a concrete expression for this writing, the question was placed before Dean Serles, as to the nature of the position occupied by the gardens, to which he replied, quoting him verbatim: "From the angle of the administration, I consider the gardens to be nothing more or less than that of a laboratory, equal in character and importance to any of the laboratories of the Division of Pharmacy, yet possibly having a different function to perform in accordance with their very nature. I consider them as a 'Living Laboratory,' vast in their potential possibilities, which, as yet, we are only but partially able to comprehend."

(b) *Publicity.*

During the past seven years, the Division of Pharmacy of South Dakota State College, has emerged from the position of a small department, occupying but one laboratory accommodating seventeen students and one lecture room, in the old chemistry building, to one of the outstanding divisions of State College at the present time. The quarters as mentioned above, marked the home of the Department of Pharmacy for some twenty-five years, the equipment of which was but fair and meagre, consisting simply of the routine list of chemicals and glassware, and two shabby laboratory desks and a

few analytical balances. The rooms were far from being comfortable, in that they were subjected to the varied atmospheric disturbances for which South Dakota is well known, and more especially, in that they possessed a northern exposure.

Since 1917, new quarters have been secured in the new Administration Building, although recognized as inadequate to fully care for the needs of the Division, yet are very commodious. Today, as one inspects the facilities of the Division of Pharmacy, one notes a well-equipped pharmaceutical laboratory and prescription room, toxicology and urinalysis laboratory, a modern pharmacognosy laboratory, equipped for all phases of pharmacognostical studies, a modern research laboratory, photographic room, quaint herb room, modern display window, the nucleus of a library, class and lecture rooms, etc., and as one walks about the campus, one cannot but help note the Medicinal and Poisonous Plant Investigations Gardens, as a prominent feature of State College.

To the one fully acquainted with the conditions that existed some seven years ago and then to compare them with what might be termed a "mushroom development," the question would necessarily come to mind "What are the causative factors for this change that has been brought about in a few years?" To ascertain an explanation for this change of affairs, there are, of course, many factors that must receive consideration, such as a change in the personnel of the Division of Pharmacy, the beneficial influence of the State Association and the alumni, administrative changes in the college proper, and to all of which may be added without fear of contradiction, the rolé played by the Medicinal and Poisonous Plant Investigations Gardens.

It is not within the realm of the present writer to define the issue at hand, having been in a large measure personally responsible for the initiatory and subsequent development of the gardens. However, it is an accepted fact that the gardens have largely entered into this transformation, but to what degree is difficult to estimate, and the writer cares not to discuss same for the reason stated above.

The question might be asked, "In what manner have the gardens played their part in this development?" This has been largely accomplished by keeping the gardens neat and orderly at all times and by means of the plant labels discussed in previous paragraphs and lastly, that the gardens as a laboratory are not behind locked doors, but are open for inspection at all times, bespeaking the activities of the Division of Pharmacy, in a silent and an effective manner. The

average visitor hesitates before entering a laboratory, but displays no hesitancy whatsoever in inspecting the gardens.

(c) *Advanced Courses of Instruction.*

For purposes of advanced instruction in all phases of pharmaco- and micro-chemical studies, the gardens are unexcelled and occupy a unique position, in that they afford the student the opportunity of selection of fresh and authentic materials.

In the present course of phyto- and micro-chemistry, as offered by the Division of Pharmacy, under the direction of the writer, to post-graduate students, they are required to prepare their personal collection of materials from the gardens, to be used throughout the course. Instruction is given at the time of collection, as to proper methods of drug collecting, drying and preservation, all of these being essential for a proper understanding of the subject.

The following represents but a partial list of materials collected in this manner for the collegiate year 1925-1926, for the work in phyto- and micro-chemistry: *Rheum, Frangula* and *Cascara* (anthra-quinone); *Althæa, Tussilago* and *Linum* (mucilage); *Althæa* (asparagine); *Inula* and *Dahlia* (inulin); *Ricinus* (fixed oil, aleurone grains and ricin); *Belladonna, Hyoscyamus, Stramonium, Nicandra,* etc. (Alkaloids); *Salvia, Tanacetum, Chenopodium* (volatile oils); *Grindelia* (resin); various flowers and fruits (pigment studies); leaves, barks, stems, etc. (histological work); *Geranium* and *Rosa* (tannin); *Capsicum* (oleoresins, organoleptic tests), etc., as well as various materials for micro-sublimation studies, study of methyl anthranilate in *Nigella damascena,* etc. A similar procedure will be adopted, at such a time that advanced work in pharmacognosy proper is offered, by the Division of Pharmacy. From the angle of colloidal plant studies, the gardens are an absolute essential, for work of this character must necessarily, for best results, be conducted upon the fresh materials.

(d) *General Laboratory Materials.*

The one fact that has been largely emphasized by previous writers in relation to the benefits to be derived from a drug garden, has been that of the question of general laboratory materials. It is difficult to estimate the value of a garden in this connection, and possibly the only way in which same may be appreciated, would be

for one who has had the privileges accorded by a garden for a number of years, to suddenly have this source of supply removed, for some reason or other. If, with this, could be coupled the advantages of a greenhouse for propagation of tropical drug plants, which facility a few schools and colleges of pharmacy possess, the material value of a garden could be greatly enhanced.

It is true that one can prepare, as a rule, a fair collection of native medicinal plants for class use, but the source of supply, of course, is governed by the locality in which the school or college is located, and if in this vicinity, the supply is very limited.

The writer will not enter into the discussion of class materials, herbarium materials, preparation of drug plant photographic series, collection of quaint herbs, etc., except to state that they are receiving consideration from year to year.

(e) *Research.*

Some one has made the remark that in the light of modern therapeutic thought there needs be a reinvestigation of practically our entire vegetable and animal (especially the former) materia medica. If this be true, then the only way in which to proceed upon this long and difficult task, will be through the employment, to the fullest extent, the facilities of a medicinal plant garden.

One has to be associated with a drug garden but for a short time, to appreciate the value and significance of a drug garden in relation to phyto-chemical research. The opportunities are unexcelled and are without parallel in this fertile field of investigation. This can be readily appreciated, as one reviews the extensive researches of Dr. Kremers on the question of volatile oil-containing plants, yet work of this character, extensive as it is, really represents but one phase or subdivision of phyto-chemistry.

In order to conduct work of this character one must keep extensive and complete notes throughout all seasons of the life of the plant. This is one of the problems now confronting the Division of Pharmacy, for work of this character will require considerable extra help. The Division is now planning to introduce the Kardex system, which will in a large measure help to reduce this extra amount of work. The writer has in course of preparation a paper dealing with "The Every Day of the Drug Garden," discussing the methods of filing, keeping of records, etc., that are essential to the proper maintenance of a drug garden.

(f) *Seasonal Variation Studies.*

During the course of a conference with Dr. N. E. Hansen, the well-known horticulturist, plant breeder and agricultural explorer, located at the South Dakota State College, the writer was informed of the fact that he, the writer, need not look forward to a similarity of climatic conditions during any two seasons in South Dakota. This advice has been found to be especially true, and has been thoroughly appreciated during the past seven years of work.

Our knowledge of seasonal variations as they affect a drug plant in relation to their respective constituents, is very meagre, to say the least, and in fact is almost lacking in the entirety. Surely, if a plant be considered an organic chemical laboratory, the processes or reactions that take place within the plant, must necessarily be influenced, in a large measure, by the change of atmospheric conditions. In order to fully understand the nature of drug plant constituents, we must as a first requisite go to the plant direct for our information. This was well emphasized by Dr. Bancroft at the time he introduced the great phyto-chemist, Ciamician, at the Eighth International Congress of Applied Chemistry, at which time he made the remark, *"In days gone by, we were told to 'Go to the ant thou sluggard;' today it is, 'Go to the plant thou chemist.'"*

Phyto-chemical investigations of a micro-chemical nature will aid in the solution of many of the complex problems now before the plant chemist. One has but to look to the work of Dr. True on the significance of the calcium ion in the living plant to fully appreciate the above statement.

This one fact, that of the necessity of micro-chemical study, was impressed upon the writer during the course of the past summer, in dealing with a micro-chemical study as to the origin and nature of the secretion of the volatile oil in the American wormseed plant (unpublished), this investigation to be accompanied by a series of tinted illustrations and tinted photomicrographs. Work of this character has furnished the writer a much greater interpretation of the entire American wormseed problem than any other one phase of this investigation.

(g) *Origin and Physiological Rolé of Drug Plant Constituents.*

The question revolving about the origin and physiological rolé of plant constituents has always been one of a great source of

pleasure, speculative comment and one that has brought forth many hypotheses on the part of the phyto-chemist. We ask ourselves, where and how do tannins originate, where and how do alkaloids, glucosides, fats, resins, etc., originate and then, why does the plant produce these innumerable substances of such complex constitution?

The solution to this problem is indeed a difficult one, for it brings into play the greatest of complexities of organic chemistry, and coupled with this is the elusiveness of the entire problem.

One avenue of approach to this problem, a rather roundabout method, as well as being one of an arbitrary nature, is that of the conduction of a series of ratio studies of a micro-chemical and quantitative nature, on the various constituents over an entire season. For work of this character one needs fresh material, of which all factors are known in so far as possible in relation to the history of the plant, climatic factors, nature of soil, cultural notes, time of collection, in fact everything that may have a possible bearing on the subject.

Then one must remember this one fact, that as soon as the living plant is tampered with in any way, shape or manner, there is an alteration of life processes, and therefore one is not dealing with the normal metabolic changes within the plant. This type of work is very applicable and essential to the study of such plants as *Podophyllum*, *Grindelia* and may in fact be applied to any of our numerous drug plants, in order to ascertain the origin and nature of the constituents, as well as to the proper time of collection.

(h) *Plant Breeding.*

That drug plant constituents are the result of a combination of underlying factors of the chemical equation type, cannot be refuted, and also that our knowledge of these underlying factors is very meagre indeed. We may ask ourselves the question, "Are the laws of heredity based purely on that of the physical or can they be explained on the basis of the chemical?" These are problems that should interest the pharmacognocist in his attempt to increase the amount or potency of the active constituency of drug plants. The writer has asked himself this question, "Is it possible to produce a strain of American wormseed plants that will yield an oil high in ascaridol content, and will it then be possible to produce seed that will come true to type?" The American wormseed growers have

discarded the so-called common "Beet seed" type of herb, saying that it will not produce an oil equivalent to that secured from other varieties. And so on, one could go through the entire list of drug plants and show a direct application of plant breeding studies, and which has in store great possibilities.

(i) *Ecological Studies.*

It is quite commonly expressed that it takes 100 years to move a plant one mile north, before it becomes fully acclimated. Probably no other one phase of pharmacognosy has received more attention than that of Ecology in its application to drug plants, in an indirect manner, for we have tackled the problem either in terms of the affirmative or the negative, without giving same a great deal of thought. This condition of affairs was brought about in our mad rush to grow, or rather to become exceedingly rich, by entering upon drug plant cultivation at the beginning of and during the great World War.

In relation to ecological studies, it is of interest to note the work accomplished at the University of Washington on the peppermint production, where they have been able to secure an oil which was double in menthol content, than that of the average oils produced in Michigan. Newcomb has shown conclusively that Minnesota Digitalis is as efficacious, if not superior, to the imported article. Johnson and Johnson, with their extensive Belladonna plantings, have added much to the history of the home production of this plant. Konantz and the writer have shown that a so-called "Western" type of American wormseed oil can be produced complying with the requirements of the U. S. P., which has upset the generally accepted theory that the so-called "Western" oils are inferior to the Baltimore oils. Doctors Sievers and Stockberger have taken an active interest in promoting work of this kind at the various drug plant gardens in this country.

Work of this character has a direct application to the commercial possibilities of drug plant cultivation, and it is of interest to note from a communication received today that the Moorman Manufacturing Company, of Quincy, Illinois, plan to make plantings of from one to two hundred acres of American wormseed next year, this work having been started by the late R. A. Konantz, former chief chemist for this company.

(j) *Let's Go Down to the Gardens for a Few Minutes.*

During the past seven years the gardens have been a source of great pleasure on hundreds upon hundreds of occasions, for it is a means of digression from the routine of the classroom and the laboratory, and at the same time allowing for worth-while recreation. It may be simply fifteen or thirty minutes of handling the shovel, the rake, the wheelbarrow, or it may be that of some collecting of laboratory materials, herbarium specimens, or, on the other hand, it may be an observation tour, in order to determine some of the characteristics of this or that plant.

Today it is a keen pleasure, yesterday, that of the first five years of the garden's existence, it was work, for the writer had to handle the entire job for the five-year period before the services of a competent gardener could be secured. Some seven years ago the writer asked Professor Newcomb some facts about the initiatory development of a garden, to which he replied, "Roll up your sleeves, pitch right in, plant everything you have on hand, and then keep after it," which advice the writer has most heartily accepted, and put into practice for a period of seven years, and still continues to do so, to a more or less extent, for one must actually be in the gardens in order to fully comprehend the work that is going on from day to day, not merely for purposes of watching the routine work, but more especially, for the interpretation of the phyto-chemical problems at hand.

Does one hesitate leaving the classroom or laboratory during vacant periods, for a walk through the gardens? The temptation is, the writer feels, in the opposite direction, namely, that to get out there among the many interesting silent friends of nature—and to reflect on the many interesting personages of the past, *e. g.*, Aristotle, Theophrastus, Galen, Buoanafede and others, all of whom in fact seem to be actually present and working with these many wonderful and quaint herbs.

To summarize the benefits to be derived from a garden, and to omit the recreational feature, would indeed be that of committing a grave injustice, for it is one of the outstanding privileges accorded those who have the opportunity of having a garden in connection with a school or college of pharmacy.

Part IV.

Future Developments.

It is a recognized fact that the easiest and simplest type of progress, research, etc., is that which is to be done in the future, being today only on paper, or in terms of Dean C. H. LaWall, the graphitic-cellulose type (memories of former days at P. C. P.). It is one problem to prepare an outline of work for the future and still another to secure sufficient funds and then to carry them through to completion.

Yet, on the other hand, the writer feels that this paper would be far from being complete, in its general make-up, if a word or two were not added as to plans of the future, which suggestions may serve as a nucleus of thought, for workers in similar fields of endeavor.

The one outstanding necessity of the future, for the general welfare of the gardens, is that of the establishment of one or more fellowships, in order to provide means for the development of those students, from our ranks, or from other schools, who desire to secure some advanced work in Pharmacognosy, Phyto-Chemistry, Micro-Chemistry, etc.

Then there is the urgent need of a modern drug milling establishment, drug drying sheds, permanent location for the new boiler plate steel still (distillation unit), greenhouses of such a character as to allow for plant breeding studies as well as for the tall tropical plants and additional cold frames are now being considered. Many fine pieces of apparatus are to be added to the modern research laboratory, including a hydraulic press for natural plant extractives (colloidal studies), all of which are necessary for the proper development of the gardens in the future.

The plans for the future expansion of the gardens may possibly call for an extension of the work on poisonous plants, the development of a native plant garden, for South Dakota, with special reference to the native medicinal plants. Here in this state we have an abundance of our State flower, *Pulsatilla, Triticum, Grindelia, Echinacea*, and many others, which are possibly not known by the writer at this time.

Probably the greatest problem confronting the Division of Pharmacy, in relation to the garden project, is that of the development of satisfactory recording systems, as to history of seed materials, cultural notes of all types, harvesting, preservation and analytical re-

sults, as were discussed in a previous part of this paper, will require a great deal of thought to perfect a workable system, and after that, comes the problem of the actual recording of all data secured, in order to fully interpret the problem at hand.

Resume.

The routine work necessary for the development of the Medicinal and Poisonous Plant Investigations Gardens has been completed, and today that which was but a realization of the future in 1918, is an actuality of today. The gardens now occupy a position equal in rank and importance to any of the major activities of the Division of Pharmacy.

To summarize that which has been said, is to say that a medicinal plant garden is essentially nothing more or less than a living and dynamic exponent of that defined by Flückiger, namely, the simultaneous application of various disciplines with the object of acquiring the knowledge of drugs from every point of view—simply that of pharmacognosy.

Without the privilege of a garden, the subject of pharmacognosy has lost its very essence of life and activity, and this privilege cannot be substituted by 95 per cent. of morphology and histology, neither can it be substituted by the antiquated lecture system, now in vogue in many of our schools and colleges of pharmacy.

Yes, a brief account of the development of the gardens as well as a few notes concerning some of the many benefits to be derived have been recorded, and commented upon, in the previous paragraphs of this paper.

Today, the Division of Pharmacy faces the beginning of a new era in the field of medicinal plant cultivation, which era of development will be found to be much more difficult in character than that of the past, for the former era simply involved the preparation of a blueprint, the transferring of the design to the plot, the expending of considerable energy in the handling of the plow, the cultivator, the shovel, the rake and the hoe, for the problem of tomorrow is one that will engage all phases of pharmaco-chemical and botanical thought, from the simplest of chemical reactions to the elusive, complex organic reactions within the very plant itself.

The Division of Pharmacy has, through the past seven years of development, looked forward to the beginning of this new era, by

accepting the challenge as handed down by Galen, Martius, Buonafede, Flückiger, Bastin, Kraemer, and many others, to whom we are greatly indebted for the heritage that is ours. There must needs be a realization of the problem that awaits the Division of Pharmacy, together with a vision of the duty to be performed in the years to come, that is, if the wishes and desires of the one to whom the gardens are dedicated, along with all the others, are to be realized.

It is extremely difficult to clearly define, by the mere combination of words and phrases, sentences and paragraphs, just what is implied in the acceptance of a challenge of this character, for one must first seek a solution to its meaning, and secondly, to put into practice that which has been arrived at in the solution of the problem.

The first fundamental factor to be taken into account by the pharmacognocist, who is essentially a phyto-chemist, microscopist and morphologist, is, that he is face to face with that relatively simple, yet exceedingly complex unit, that which man can neither create nor fully understand, that of the *Living Cell.* With all the modern inventions of science, man today finds himself in a respectful and humble position before the lowly blade of grass and he is forced to admit, "How do you do it?"

In order to ascend to the second rung of the pharmacognostical ladder, that of an understanding of the many wonderful chemical transformations and syntheses, that daily take place in these thousands upon thousands of microscopic, organic chemical laboratories, we must at least attempt to secure an understanding of the first problem, namely, that as just previously expressed, the living cell. Then we will be in a position to delve into the mysteries as to the origin and nature of the formation, secretion or otherwise, of the many active plant constituents that man utilizes for their marked therapeutic value.

From our present knowledge of pharmacognosy, phyto-chemistry or whatever one may choose to call it, we are in practically every case forced to tackle the problems before us in a roundabout manner, due to our present lack of these fundamental factors.

Possibly no other single phase of the American wormseed investigation, upon which the writer has been engaged for some four years, has presented more for an interpretation of the problem at hand, than by accepting the words of Bancroft, "Go to the plant thou

chemist." By that, the writer means, through a micro-chemical means of attack.

Colloidal chemistry will no doubt tend to play an important rolé in future drug plant chemistry, and it will be through a study of colloidal behavior that the plant chemist will have placed in his hands the proper tools for future investigations.

We speak of the active constituents of *Belladonna,* of *Opium,* of *Nux Vomica* and the like; we speak of tannins, of resins, alkaloids, glucosides, anthraquinone derivatives, but as one reviews the field of pharmacognostical and phyto-chemical literature, all one notes for the most part is a series of hypotheses, especially in relation to the origin and function of plant constituents, and in many cases even in relation to their very chemical constitution. A great work has been done in the past by those who have devoted their lives to work of this character, but think of the vast potential possibilities that await the plant chemist of the future.

Then, as we turn away from speculative comment, such has been engaged in throughout the past few paragraphs, and our attention is called to pharmacognosy, such as is being offered by many of our schools and colleges of pharmacy, we can readily appreciate and fully understand the statement by Wirth, when he states that the fertile field of pharmacognosy is being riddled, ransacked and looted by others than pharmacognocists.

Are we, in terms of the school or college of pharmacy, prepared to utilize that which a garden has to offer, or do we simply utilize but two of the benefits that it offers, namely, publicity and general laboratory materials? Let us look about our pharmacognosy laboratories and see if they are so equipped, so as to make possible, the utilization of that which this living exponent of pharmacognosy has to offer. The writer is glad to add, in bringing this paper to a close, that the Division of Pharmacy, South Dakota State College, has taken the beginning step in this direction, by the equipping of a modern pharmacognosy laboratory, so as to enable the student of pharmacognosy the privilege to conduct, not only morphological and histological studies, but chemical and micro-chemical as well. In addition, a modern research laboratory has been quite fully equipped with standard apparatus during the past year, all of which represents in part some of the aims of the Medicinal and Poisonous Plant Investigations Gardens, and on the whole, that of the aims of the Division of Pharmacy.

Acknowledgments.

The past seven years of endeavor, especially as they relate to the development of the Medicinal and Poisonous Plant Investigations Gardens, has been a period that has afforded the writer many hours of pleasureable and educational pastime. This pleasure was not alone experienced in the hours spent in the gardens, but as well, the hours spent with the Masters of the Past, and the many kindred friends of the present, all of whom are largely responsible for that which, today, marks the only garden of its kind in the State of South Dakota.

It is an added pleasure, at this time, to gratefully acknowledge the kind services of all who figured in the development of these gardens. The writer has endeavored throughout the course of this paper, to call attention to the great service rendered by the Masters of the Past, the early rhizotomists, herbalists and the bearded apothecary, all of whom have played an important rôle in the endeavors on the part of the writer during the past seven years, for many of the thoughts embodied in this work are essentially those gleaned from the lives of these interesting personages, the forefathers of our profession.

To return to the present period, the writer first wishes to acknowledge the valuable services rendered by Dr. W. W. Stockberger, Senior Physiologist, Drug, Oil and Poisonous Plant Investigations Laboratory, Bureau of Plant Industry, Washington, D. C., to whom the writer has appealed for aid on many occasions, and whom the writer has always found to be most obliging and willing to co-operate in whatever manner possible. The American drug gardens of today owe much of their very existence to the untiring endeavors on the part of Dr. Stockberger, for his office and laboratory have been most active in the distribution of valuable propaganda, seed and plant materials, etc.

To Dean E. R. Serles, the writer wishes to express his appreciation for the personal manner in which he has placed at the disposal of the writer the facilities of the Division of Pharmacy, as well as for the many kindly suggestions and material aid rendered from time to time.

The writer also wishes to acknowledge the many courtesies extended him by Dr. N. E. Hansen, Director of the Department of Horticulture, which included many suggestions and kindly criticisms,

and in addition the granting of the garden sites, valuable greenhouse space as well as the facilities of the department in general. In this connection, the writer also wishes to thank his two associates, Messrs. William Wood and A. Larson, for valuable services rendered.

The many kind words of encouragement, as well as the financial aid rendered in connection with the American Wormseed problem, and also the tendering of the D. F. Jones Fellowship of $1000 by Mr. D. F. Jones, of Watertown, South Dakota, are gratefully acknowledged at this time.

Professor E. L. Newcomb has also been most kind in response to the many requests on the part of the writer, all of which the writer wishes to acknowledge at this time.

Acknowledgment is also made of the kindly aid given by Professor P. L. Keene, Director of State College campus, who has most willingly placed at the disposal of the writer the facilities maintained by the college in connection with the proper maintenance of the campus.

In conclusion, the writer wishes to thank the administration of State College as a whole for the kindly encouragement received in the past and present, all of which has aided in a material manner to establish the gardens as an integral and permanent feature of State College.

IODOLE FROM A NEW SOURCE—ITS PROPERTIES.

By Joseph Michelman, S. B., Chemist.

"Iodole" is tetraiodopyrrole and is synthesized from pyrrole, which explains why this valuable drug has heretofore not been freely available. Pyrrole itself has not been accessible because its extraction from the previous best source (bone-oil) is a matter of difficulty. The writer has recently described [1] a method of obtaining pyrrole readily from the destructive distillation of scrap leather. Because of the purity and the larger yields of the pyrrole obtained from this plentiful and inexpensive source, pyrrole will now be available to prepare Iodole. A description of the preparation and the properties of this undeservedly rare antiseptic may be of interest.

(Numbers in text refer to bibliography at end of article.)

Preparation of Iodole.

Iodole was first prepared by Ciamician [2,3] and his co-workers by the action of iodine in potassium iodide on pyrrole in alkaline solution.

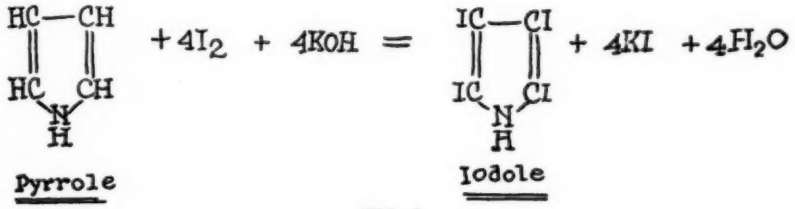


FIG. 1.

Another method [4] was proposed whereby alpha pyrrole carboxylic acid could also be used to make Iodole. This is of particular interest at present. One of the products resulting from the destructive distillation of leather scrap is pyrocoll. This substance readily decomposes into two molecules of alpha pyrrole carboxylic acid upon boiling with alkali, with almost quantitative yields.

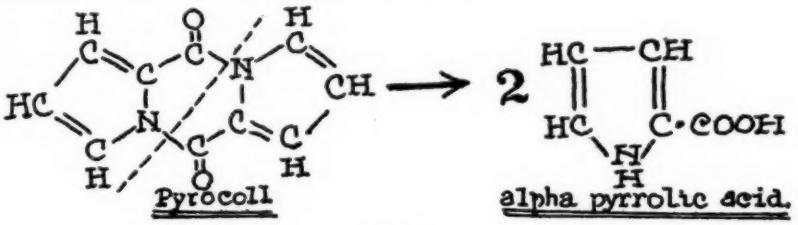


FIG. 2.

Pyrocoll can be easily purified by sublimation; it is comparatively stable; and since there seems to be no other good industrial use for it at present, it might be used as the starting point for making Iodole. Pyrrole itself will of course also be available for making Iodole.

The yields in the preparation of Iodole from pyrrole are entirely satisfactory. Datta and Prosad [5] have proposed a method for the quantitative determination of pyrrole based on its conversion into Iodole.

Properties and Uses of Iodole.

Iodole is an iodine antiseptic and resembles iodoform in its action. In fact, of the various iodine derivatives that have come into use, only Iodole resembles iodoform in that its action is due to the

actual liberation of iodine. Iodole, however, differs from iodoform in that iodoform has serious drawbacks such as a persistent odor and an irritant action on the skin giving rise to a kind of eczema; and it has toxic properties which sometimes give rise to definite symptoms of poisoning. On the other hand, Iodole is said to be non-irritant, odorless and possesses little, if any, toxicity. The iodine in Iodole is evidently in a labile state and is decomposed upon contact with tissue setting free the iodine. Iodole contains 89 per cent. iodine and is thus an excellent antiseptic.

The development and use of Iodole has been prevented by the scarcity of pyrrole. Little work has been done recently on its physiological and therapeutic properties. Ciamician[6] pointed out that Iodole was successfully applied in venereal, ulcerous and suppurative lesions. After administration of Iodole, half of the iodine is found in the urine, and on this basis, Iodole can be used as a substitute for potassium iodide. Iodole may be employed locally as a spray for throat infections, as a powder, as an ointment, as a mixture with collodion or vaseline, or as a solution of Iodole in glycerine and alcohol.

"Iodalbumen" from Iodole.

Iodole forms a fairly stable compound with egg albumen. This iodole-albumen,[7] or Iodalbumen, is a yellow, tasteless and odorless powder, insoluble in water and the usual solvents, but soluble in warm dilute alkaline solution. These compounds have been called "iodolen" of which there have been proposed two kinds: "Iodolenum external" and "Iodolenum internal" containing 36 per cent. and 9 per cent. respectively, of Iodole. As the names imply, these compounds are intended for external and internal administration.

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[1] *J. Ind. & Eng. Chem.: 17,* 247 (1925), and *17,* 471 (1925).
[2] *Berichte: 15,* 2582 (1882), and *18,* 1766 (1885).
[3] German Patent No. 35,130 (1886).
[4] German Patent No. 38,423 (1886).
[5] *J. Am. Chem. Soc.: 39,* 451 (1917).
[6] *Gazzetta: 16,* 543 (1886).
[7] German Patent No. 108,904 (1899).

Also the following books: Fränkel "Arzneimittel-Synthese" (1919); Percy May: "The Chemistry of Synthetic Drugs" (1918 or 1921); Sollmann: "Manual of Pharmacology" (1917); Barrowcliffe and Carr: "Organic Medicinal Chemicals" (1920).

AN INEXPENSIVE PHOTOMICROGRAPH ATTACHMENT.

Henry Leffmann.

Photomicrography has become widely applicable in many phases. For ordinary lecture illustration it is much more convenient and satisfactory than the direct projection of the specimen, which is likely to be injured by the heat of the lamp. The available processes of color photography enable the teacher to secure excellent pictures of stained specimens or of sections under polarized light. For the latter purpose the photomicrograph is especially aplicable, as the apparatus for polariscope projection in the lantern is very costly, and the delicate optical train is liable to be injured by the heat.

Most photomicrographic apparatus in the market is adapted to horizontal operation. This is quite satisfactory with mounted specimens or opaque objects such as minerals or metals, but does not suit for fresh mountings. Apparatus for direct attachment to the vertical microscope has been devised. It is to be regretted that the makers of photomicrographic apparatus have so little originality. One defect of almost all forms in the market is that the plate-holder is made after the pattern of those used in cameras intended for outdoor work with which lightness is important. Photomicrography is not such a procedure. A double plate-holder is not needed, and it should be made deep so as to permit of more satisfactory use of kits. The Walmsley camera devised many years ago and for some time in active use, had a single plate-holder, but it was very shallow. Most forms of apparatus are intended for use outside of the dark room, which necessitates the use of the standard holder. In the horizontal apparatus it is an advantage to use a mirror placed at an angle of forty-five degrees to the axis of the camera, by which the image on the ground glass can be seen conveniently while focusing. It is not germain here to speak of methods of making the pictures, but I wish to mention that I have found the use of panchromatic plates with interposition of a red screen, between the light and the object to give better detail in many cases, and I have also used with advantage to the high contrast developer given in the slip accompanying process plates.

The photomicrographic camera may be much simplified by working it in the dark room, by which the dark slide may be entirely

eliminated. The photographic laboratory of the Philadelphia College of Pharmacy and Science is equipped with a satisfactory horizontal apparatus, but lately it was desired to make photographs of some crystals in the mother liquor and a simple attachment to the vertical microscope was devised. It was mostly made of wood from cigar boxes. Briefly, the construction is merely a box about eight inches high, with interior measurements of four and one-half inches in one direction and three and one-half inches in the other, thus taking nicely the standard 4¼ x 3¼ plate. The lower end is closed by a board about one-half inch thick, perforated so as to take snugly the draw-tube of the microscope, which is pushed through until the flange abuts on the upper surface of the board. This permits the insertion of an eye-piece if desired. About half an inch below the upper rim of the box two small rests are fastened. These must, of course, be carefully adjusted so that the plates will rest level and firmly. The box should be painted a dead black inside and out, and provided with a well-fitting lid. Obviously the apparatus may, with slight additional expense, be more elaborately constructed. Among other modifications the draw-tube might have an outside thread which will fit into a flange on the bottom after the manner of the ordinary lens board. In operation, the ground-glass is laid on the rests, the focus adjusted, the glass removed, a sensitive plate substituted and the lid put on. If deemed necessary a cloth may also be thrown over the top of the box. It is, of course, understood that lights, except the usual dark-room light, are out while the change from ground-glass to sensitive plate is made.

The box may be modified by making it in the form of the frustrum of a pyramid with the bottom board only about two inches square. In the form described the apparatus has cost almost nothing and has proved satisfactory.

SCIENTIFIC AND TECHNICAL ABSTRACTS

INSECTICIDES AND FUMIGANTS.—At a recent lecture before the Philadelphia Branch of the American Pharmaceutical Association, Professor Lewis Gershenfeld referred to facts and fancies concerning insecticides and fumigants. Random notes of the lecture include the following data:

Baits—

Ants and Flies—

Arsenic Compounds—Sponge saturated with a mixture of one ounce of sugar, ten grains sodium arsenate, and three ounces of water. Care to be taken to safeguard children.

Formaldehyde—one ounce of formaldehyde to one quart of milk or sweetened water.

Rats—

Sodium Silicate—one ounce to one quart of sweetened water.

Barium Carbonate—25 per cent. in cereal or sweet cheese.

Plaster Paris in flour or cereal—for rats and roaches.

Phosphorous Compounds.

Traps—

Flies and Roaches—

Trap with following bait: fermented molasses, one ounce to three ounces of water.

Hot water to kill the trapped insects; this method destroying eggs and all.

Moths—

Bags and cedar chests—treating material first by shaking and aerating.

Refrigeration plants for storage.

Strong Heat.

Fumigants and Insecticides—

Formaldehyde Gas—a fumigant but not an insecticide.

Hydrocyanic Acid—Very valuable but great danger in its use unless handled by a skilled operator.

Sulphur Dioxide—Very valuable in proper concentration—three to three and one-half pounds to 100 cubic feet space and allowed to remain from six to twelve hours.

Contact Insecticides—

Kerosene, Gasoline, etc.—quite satisfactory.

Carbon Disulphide and Carbon Tetrachloride—Too costly for the amount required.

Sodium Fluoride—Most valuable of powder type—dilute with flour.

Naphthalene—Large amounts necessary for fleas and moths.

NEWS ITEMS AND PERSONAL NOTES

DETECTION OF ETHYL PHTHALATE IN ETHYL ALCOHOL. J. T. RALEIGH AND S. U. MARIE. (Through *The Analyst.*)—The United States Government official test for the detection of ethyl phthalate in ethyl alcohol, depending on fusion with sodium hydroxide and treatment with resorcinol to form fluorescein, is found to be unreliable, as it gives a distinct fluorescence in absence of ethyl phthalate. The following test, although not conclusive, gives strongly indicative results: One hundred cc. of the alcohol is evaporated to small bulk and then poured into a large volume of water containing a few cc. of sodium hydroxide solution; a milky cloud of ethyl phthalate will develop if this denaturant is present. The boiling point of the ester (290-297 degrees C.) serves as a confirmatory test.

OIL OF DACRYDIUM CUPRESSINUM.—The presence of this oil in a widely-used American proprietary, as testified upon the label of the medicinal, makes the following item worthy of note.. The red pine *Darydinum cupressinum,* Salander, is abundant in the forests throughout New Zealand. F. H. McDowall and H. J. Finlay (*Journal of the Society of Chemical Industry*, January 23, 1925) extracted the oil from 236 pounds of leaves with terminal branchlets, obtaining 180 grams of oil, a yield of 0.17 per cent. Treatment of the oil in ether with a saturated solution of sodium hydrogen sulphite gave no trace of a bisulphite compound, indicating the absence of aldehydes and ketones. The ether solution was dried over sodium sulphate, and the ether removed. The oil, when allowed to stand, was found to deposit considerable quantities of a solid, in the form of large tabular crystals. After three recrystallizations from absolute alcohol, the substance gave the following constants: Melting-point, 55.5 degrees; boiling-point, 320 degrees; $[a]_D$ (in chloroform), 53.7 degrees; H 12.0 per cent., C 88.0 per cent.; molecular weight (cryoscopic method in benzene), 269. Calculated for $C_{20}H_{32}$, H 11.8 per cent., C 88.2 per cent.; molecular weight, 272. The substance produced no decolorization of bromine water or of bromine in dry ether, and had no effect on potassium permanganate. It was thus shown

to be a saturated pentacyclic diterpene. *Examination of residual oil.*—This was fractionally distilled at a pressure of 31 mm. The fraction boiling between 180 degrees and 220 degrees at that pressure was a blue oil from which a white, crystalline solid separated. This, after being freed from oil on porous tile and recrystallized from absolute alcohol, had a melting-point of 40 degrees to 48 degrees. The dark-colored residue remaining in the distillation flask also crystallized on standing. The oily mass of crystals was drained on tile and the resulting white solid recrystallized from methyl alcohol, from which it separated in thin flakes, melting-point 92 degrees, C 87.8 per cent., H 12.2 per cent. This solid also proved to be a diterpene. By repeated fractional crystallizations from alcohol, the substance of melting-point 40 degrees to 48 degrees was shown to be a mixture of the two diterpenes of melting-point 55 degrees and 92 degrees, in which the former greatly predominated. The pure compound of melting-point 55 degrees, when heated to its boiling-point and allowed to cool, showed a lowering of melting-point to 45 degrees to 52 degrees, indicating the formation of a small amount of impurity by isomeric change. Hence, it is probable that the substance of melting-point 92 degrees is formed by isomeric change from the lower-melting diterpene, during the course of distillation. Further fractionation of the small amount of oil remaining yielded a definite sesqui-terpene fraction; boiling-point 152 degrees-157 degrees at 40 mm., nD ^{20} 1.5005, *d.* $_{20}{}^{20}$ 0.9219 [*a*] D (in chloroform) + 17.81 degrees; C 88.1 per cent.; H 11.8 per cent.

THE PRODUCTION OF CHLORINE BY ACTION OF HYDROCHLORIC ACID ON CHLORATES.—This reaction has long been used for the quick preparation of small amounts of chlorine for tests, but as chlorine oxides are also formed in notable amount, which are unstable and rather violently explosive, the process has been considered inapplicable on the large scale. E. Dufilho, however, presents a detailed account of a modified process which is safe, in the *Bull. d. Trav. d. l. Soc. d. Pharm. d. Bord.* (1925, *63*, 41). After noting the danger of the unmodified process, Dufilho states that all the chlorine oxides are decomposed at temperatures below 95 degrees C., and he devised apparatus by which the reacting liquids can be kept at the safe temperature, so that the oxides are decomposed as fast as formed and,

therefore, cannot accumulate in sufficient quantity to do harm. That the explosion of a considerable amount of these can be serious was shown in a preliminary experiment in which a solution of sodium chlorate was allowed to flow drop by drop into hydrochloric acid, and the evolved chlorine dehydrated by passing through strong sulphuric acid. The heat evolved by the absorption of water caused an explosion which destroyed the apparatus and even broke some of the laboratory windows. In addition to the regulation of temperature the reaction must be carried out constantly in the presence of excess of acid. The author of the article states that the process has not heretofore been published, but was used on the large scale in the preparation of pure chlorine in connection with the French Chemical Warfare Service. He gives details of the construction of the apparatus used. He also gives data in regard to a modification by which a mixture of sodium chloride and sulphuric acid is used instead of hydrochloric acid itself. Sodium chlorate is used instead of the potassium salt on account of the much greater solubility of the former. It seems, however, that the process can hardly compete in cost and convenience with the processes generally used for the production of chlorine on the large scale. H. L.

PHENOLPHTHALEIN AS A REAGENT FOR DETECTING THE DECOMPOSITION OF ANÆSTHETIC ETHER. J. Stamm (Pharmacia, 1924, September, eight pages; *Chem. Zentr.*, 1925, through *Jour. Soc. of Chem. Ind.*, *96*, I., 996).—Phenolphthalein (1 g.) is boiled with water (20 g.), sodium hydroxide (10 g.), and zinc dust (5 g.) until the solution is colorless, diluted with water to 50 cc., and filtered through asbestos. One drop of this solution is mixed with 1-2 drops of copper sulphate solution (1:2000), and 0.5-1.0 cc. of the ether to be tested is then added. If the latter is undecomposed, the reagent remains colorless, but if peroxides are present a ring colored pink to intense red is formed at the surface of separation of the two liquids. The Nessler test should be carried out in addition to the above, as this detects higher degrees of decomposition. Anæsthetic ether should be stored in brown bottles covered with black paper, as brown bottles alone give no satisfactory protection against light, nor against electricity.

PARA-NITROBENZOIC ACID AS AN ACIDIMETRIC STANDARD.—Benzoic acid having been shown by experience to be an excellent primary standard for acidimetry, Thornton and Getz, working in the Johns Hopkins Chemical Laboratory have experimented with the 1-4 nitro derivative of the acid with a view to determine its suitability for such purpose. The methods used and the results are given in a paper in the *Amer. Jour. Sci.* ([5], 1925, *9*, 176). The investigation was comprehensive and thorough. The conclusions are as follows:

Para-nitrobenzoic acid proves to be an accurate primary standard in neutralization processes. It is readily purified—two or three crystallizations from alcohol being all that is necessary when one starts with material of fair quality. Not being bulky, it is easy to weigh and transfer. It requires no fusion, mere drying at 120 degrees, which is far below its melting point, being sufficient. It does not seem to be more than ordinarily hygroscopic—a possible point of superiority as compared with benzoic acid. Its high molecular weight permits taking large samples with the attendant increase in accuracy.

H. L.

THE COLORING MATTER OF PRIVET BERRIES.—A water-extract of the berries of *Ligustrum vulgare* L, is used in Germany for improving the color of wine. It seems that no careful chemical examination has been made of the color, and Ernst Pfau presents in *Archiv d. Pharmazie* (1925, *263*, 50) the results of a preliminary study. The work was done in the laboratory of the Chemical Institute of the Veterinary School of Hanover.

The berries were extracted with warm water and the solution filtered. The filtrate was bluish-violet and slightly acid to litmus. Ferric chloride gave a green tint, lead acetate a deep blue precipitate, the filtrate from which gave no visible reaction with the subacetate. The original solution of the color produced no foam when shaken, showing the absence of a saponin. Fehling's solution was reduced after prolonged boiling. Dilute sulphuric acid turned the original solution red, and excess of ammonia turned it blue. Alcohol extracted a blue substance, but no extraction was noted with ether or chloroform. Permanganate solution was decolorized. No evidence of alkaloids was found.

A second procedure was extraction with alcohol acidified with tartaric acid. The deep red liquid was concentrated on the water bath, extracted with water, filtered and the filtrate extracted with ether both in acid and alkaline condition. The residues from these extractions gave no reaction with Mayer's reagent, and extraction of the ammoniacal solution with amyl alcohol was also without definite result. To avoid possible changes in the use of sulphuric acid to decompose the lead precipitate, a different method was adopted. One hundred grams of the berries were extracted with glacial acetic acid and the solution precipitated by ether. This precipitate was purple-red. It was drained and washed with ether. A portion dissolved in water and picric acid was added. Fine red highly refracting needles were thrown down. Some further experiments were made but the amount of material available did not permit of complete examination. The result of the preliminary tests here summarized is that the coloring material, which is termed "ligulin," is analogous to oenin. H. L.

THE COMMONWEALTH STUDY OF PHARMACEUTICAL EDUCATION. BULLETIN NO. 6.—This is the sixth of a series of twelve monthly statements to be issued by the staff conducting this study.

Bulletin No. 5 carried in response to a general request from publishers and readers of pharmaceutical journals, some results of the survey of nearly 1200 retail stores, which was conducted last summer. Now comes a request from textbook writers who are revising their textbooks.

The director of the study appreciates how valuable the results of this research will be to textbook writers and wishes to co-operate fully with any who care to take advantage of the findings. However, it is impossible to distribute any material at this time since nothing in the nature of finished reports has been reviewed and passed upon by the Advisory Committee. Since most of the studies are correlated they cannot be worked out independently and released for publication.

Following is a list of the headings under which the study is being conducted. Where assistance is being given by men outside the staff the names are given.

Mimeographed copies of the final report on each topic will be ready for distribution at cost after October 1, 1925.

Pharmaceutical Jurisprudence.—Dr. J. H. Beal, H. C. Christensen.

Pharmaceutical Traits and Ethics.—Dr. W. W. Charters, Mrs. E. H. Kenagy.

Types of Ingredients in 16,000 Rx studied, known as Type of Ingredient study and discussed in Bulletin No. 3.—Staff.

Nomenclature study was discussed in Bulletin No. 4. The Latin was worked by Prof. L. H. Monell and is now being reviewed by Dean H. C. Muldoon.

Arithmetic.—Staff:

Dosage, including Veterinary Dosage.—Staff.

Toxicology.

Physiology.

Pharmacology.

Active Constituents.—These three studies are being worked together by Dr. A. R. Bliss, Jr., and when completed will be reviewed by Dr. Torald Sollmann.

Botany and Pharmacognosy, including georgaphical source, collection and preservation, adulteration and contamination. These studies are under the direction of Dean H. H. Rusby.

Physics and Chemistry are being studied under the direction of Dean Edward Kremers.

Bio-assaying.—Dr. P. S. Pittinger is assisting in this study.

Bacteriology and Immunology.—Staff.

Manufacturing.—What should be manufactured by the pharmacist, has been determined by questionnaires sent to many teachers and pharmacists. The problems involved in manufacturing are being studied by Prof. E. Fullerton Cook.

Compounding and Dispensing.—Compounding problems as drawn from 16,000 prescriptions studied. Study being conducted by Dr. Louis Saalbach.

Pharmaceutical English, History and Orientation being studied by Dr. W. W. Charters.

Public Health, Sanitation, Hygiene, First Aid, Clinical Work.—Study being made by U. S. Public Health Service.

Insecticides and Fungicides by U. S. Department of Agriculture.

Library (methods of stimulating use of), by the Staff.

When completed the report will show just what information the pharmacist needs on these various topics.

AMERICAN PHARMACEUTICAL ASSOCIATION COMMITTEE ON RESEARCH.—The American Pharmaceutical Association has available a sum amounting to $450 which will be expended after October 1, 1925, for the encouragement of research.

Investigators desiring financial aid in their work will communicate before July 1 with H. V. Arny, Chairman, A. Ph. A. Research Committee, 115 West Sixty-eighth Street, New York, N. Y., giving their past record and outlining the particular line of work for which the grant is desired.

BOOK REVIEWS.

BEACON LIGHTS OF SCIENCE. A SURVEY OF HUMAN ACHIEVEMENT FROM THE EARLIEST RECORDED TIMES. By Theo. F. Van Wagenen. 8vo., 444 pp., with 6 Illust. Cloth, $3. Thomas Y. Crowell Co., N. Y. City.

This excellent book presents an outline of the development of science throughout the centuries, in the lives of those who have contributed notably to its progress—"torchbearers" during three thousand years of recorded history! Here grouped in their proper perspection we see them—the astronomers, anatomists, botanists, chemists, biologists, geologists, physicists, physicians, physiologists, electricians and many others—an almost complete roster of "beacon lights," which is selected as the title, the proper title of the book.

The text is divided into six chapters, the number of biographies are noted in parentheses: I, Ancient Times (20); II, Middle Ages (11); III, Sixteenth Century (15); IV, Seventeenth Century (17); V, Eighteenth Century (68), and VI, Nineteenth and Twentieth Centuries (92). Beginning with Thales (624-560 B. C.) the author gives the life stories of the great thinkers up to the present time, concluding with Einstein (1875-). He traces the progress of discovery, century by century, in a series of terse but interesting biographies. Of interest to pharmacists will be those of Hippocrates, Theophrastus, Dioscorides, Galen, Da Vinci, Vesalius, Galileo, Boyle, De Jussieu, Linnaeus, Cavendish, Priestly, Scheele, Lavoisier, Dalton, Oersted, Davy, Gay-Lussac, Berzelius, Ohm, Daguerre, Henry, Dumas, Woehler, Liebig, Bunsen, Helmholtz, Kirchoff, Huxley, Kekulé, Mendeleef, Dewar, Koch, Roentgen, Moissan, Fischer, van't Hoff, Arrhenius, Curie, and many more.

The book is finely bound well printed and handsomely illustrated with photographic reproductions of a series of bas-relief portraits in bronze decorating the new million-dollar building of the National Academy of Sciences and the National Research Council in Washington, D. C.

It is a book which the referee can highly recommend!

OTTO RAUBENHEIMER, Ph. M.

FOLKENAVNE PAA LAEGEMIDLER OG DERES OPRINDELSE. SAMLET AV EINAR JANSEN, CAND-PHARM. 46 pp. Norges Farmaceutiske Forening. Kristiania.

This is the second edition, the first one being published in 1911, of a dictionary of popular and vernacular Norwegian names for drugs and preparations with the corresponding Latin or official titles. It might be of interest to learn that the Scandinavian Pharmacopœias still cling to the old Latin names of chemicals, f. i. Boraks = Bibor natric., and Vitriol = Sulf. ferros. crud., and Vinsten = Bitartr. Kali., etc.

The compiler, a pharmacy candidate, in a condensed form also traces and explains the origin of many terms, f. i. Pain Expeller = Lin. capsic. comp., Pain, eng. = sting, hold; Expel, eng. = fordrive, utjape.

The monograph furthermore contains much interesting matter to the student of folklore, as many valuable etymological and historical references are included in the explanation of the Norwegian names, f. i. Seignette salt = Tart. antr. Kalic', named after the French apothecary Seignette in La Rochelle who accidentally prepared this salt in 1672. Gratia probatum = 01. terebinth sulfur., official in Ph. Norv. 1854. Its origin is traced to Claus Tilly, of Haarlem in 1698.

At least in one instance the referee, who has made somewhat of a study of pharmaceutical synonyms in many languages, cannot agree with the compiler, namely, that Tolutanbalsam = Tinct. benz. comp. However, it could be possible that for counter use when the customer expects a liquid for ready use the Norwegian apothecary dispenses "Friar's Balsam," containing Balsam of Tolu at least as one ingredient.

This monograph should be welcomed not only by students of philology and etymology but also of folklore and history of pharmacy, chemistry and medicine.

OTTO RAUBENHEIMER, Ph. M.

CARSO DI FISICA E CHIMICA. By A. Funaro and R. Pitoni. 6th edition, in 3 Octavo volumes. Raffaello Giusti, Livorno.

This well known work, one of the best in Italian scientific literature, consists of three volumes and is in its fifth, respectively sixth, revised edition.

Volume I, of 138 pages, with eighty-nine illustrations, contains a General Introduction and the usual chemistry of Non-Metals and Metals. Besides, three chapters are devoted to Organic Chemistry.

Volume II, of 263 pages, with 230 illustrations, is devoted to Physics, containing Mechanics of Solids, Liquids and Gases, Molecular Action, Sound and Cosmography. The last chapter, which is not usually found in a book on physics, can be hailed as an innovation.

Volume III, of 280 pages, with 299 illustrations, contains the following: Heat, Optics, Magnetism, Electricity and Meterology, each subject again being divided into from two to thirteen chapters.

The treatment is modern throughout the three volumes. Although especially adapted for the study of physics and chemistry in the colleges of Italy, it is a valuable work, containing much up-to-date information, and therefore should find a place in the libraries of the United States.

OTTO RAUBENHEIMER, Ph. M.

PROTEINS AND THE THEORY OF COLLOIDAL BEHAVIOR. By Jacques Loeb. Second edition. 12mo. 380 pp. Cloth, $3.50. McGraw-Hill Book Co., 370 Seventh Ave., N. Y. City.

Since the publication of the first edition of this valuable book in 1922, Dr. Jacques Loeb, of the Rockefeller Institute for Medical Research, carried on numerous experiments which contributed important corroborative evidence of his theory of colloidal behavior. The results of these recent experiments were incorporated in the German and French editions of the work. The second edition in English was prepared in accordance with the foreign editions by the author before his death.

The book is divided into two parts. I, Crystalloidal and Colloidal Behavior of Proteins, and II, Theory of the Colloidal Behavior of Proteins. Among the twenty-one chapters I will call special attention to the following ones:

I, Historical Introduction, containing a mass of valuable information.

VI, Crystalloidal Character of the Solutions of Certain Genuine Proteins in Water.

VIII. Action of Dental Salts on the Physical Properties of Proteins.

X, Introductory Remarks About the Lode Theory.

XII, Osmotic Pressure.

XIV and XV, Viscosity.

XX, Some Experiments on Solutions of Proteins in Alcohol-Water Mixtures.

XXI, Concluding Remarks.

The sixty-six tables and 115 figures with which the book is illustrated greatly help to elucidate the text. A very complete, eight-page, double-column index serves to make the volume very efficient.

Jacques Loeb is dead, but his work and especially this book will live after him!

OTTO RAUBENHEIMER, Ph. M.

ORGANIC MEDICAMENTS AND THEIR PREPARATION. By Ernest Fourneau, Head of the Institute for Therapeutical Chemistry in the Pasteur Institute; member of the Academy of Medicine; formerly Director of the Poulenc Laboratories. Authorized translation by W. A. Silvester, with prefaces by Emile Roux and George Barger. 257 pages and index, 22 illustrations. P. Blakiston's Son & Co., Philadelphia.

This is a book of unusual character. Most books on laboratory work in organic chemistry confine themselves to the preparation of substances of purely academic or historic interest.

With this book it is different. The substances prepared are those of practical use and outstanding value in the practice of medicine. Antipyretics, hypnotics, local anæsthetics, antiseptics, organic

compounds of arsenic and of mercury, adrenalin, nucleic acid and alkaloids, are the principal groups represented. In connection with each group the author discusses the physiological action of the various compounds and the relations, if any, between that property and the chemical constitution.

The chapter on setting up apparatus and specific recommendations to beginners are models of completeness and conciseness.

Among the specific substances for which directions for preparation are given are the following familiar drugs: guaiacol, phenacetin, acetanilid, antipyrine, acetylsalicylic acid, stovaine, acetophenone, diethylbarbituric acid, adrenaline, mercury benzoate, salvarsan, calcium glycerophosphate, lecithin, atropine, digitalin, etc. The book closes with a fairly complete chapter on the bibliography of the subject, and an excellent index.

Every medical college and every pharmaceutical college, and many private research laboratories can make excellent use of this book.

It should be in every pharmaceutical and medical reference library as well.

CHARLES H. LAWALL.